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INDEX Vol. 6

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For the greater convenience of the reader this index has been made both titular and topical in nature. Original titles of articles have been amplified or condensed for the purposes of the index as seemed best. Subjects have been indexed which are treated in articles and not originally embraced in the title. Nothing has been indexed under "concrete" and nothing under "cement" except when the nature or testing of cement is involved or some statistics as to its production or use. In short, "cement" has been used as an index word only when it appeared as the only comprehensive way of designating the matter. Illustrated articles are denoted by an asterisk after the title. Editorials are designated by "E"; articles in the Information and Consultation department by "I-C"; Correspondence department matter by "C" and New Equipment Methods and Materials department articles by "Eq." The months and pages are given.

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Concrete-
Cement Age

Vol. 6 *Detroit, January, 1915* *No. 1*

The Concrete House

THAT "the concrete house" is elusive of definition is made evident in this issue of this magazine. Cast-in-place houses with solid walls and with double walls, with steels forms, and with unit wall apparatus; houses of pre-cast units varying from the relatively small block units to light thin sections for double walls and large two-and three-ton units handled by an electric crane—all these are in evidence. Then in the matter of architectural development there are various stucco treatments, brushed and rubbed surfaces and beautiful color effects. The concrete house is not one kind of house. Concrete is a universal material and its variety of applications does not lag in realization through any inherent sameness in the material itself, either structurally or architecturally. The applications merely wait upon a skilled hand to work them out. That they *are being worked out* to meet various demands of purse and taste there is evidence in the pages which follow.

The Edison Fire

THE destruction of the Edison plant at West Orange, N. J., the night of Dec. 9, 1914, which is to be classed as a conflagration and not as an ordinary fire, merits considerable comment, elsewhere in this issue, in view of the unusual character of the fire, the widespread interest in engineering and insurance circles, and the behavior of several types of buildings under unusual stress, including structures of reinforced concrete.

The contents of the Edison buildings were of the most inflammable and heat-creating types, including wood used in the manufacture of cabinets, celluloid for films and wax for phonograph records, chemical supplies and other material of a highly inflammable character.

The seven reinforced concrete buildings (as well as other types of buildings) were equipped with plain glass windows in wooden frames and surrounded by wooden structures, no provision being made for any automatic sprinkler or emergency water service.

With few exceptions, the behavior of the reinforced concrete buildings under the severe exposure to fire is a notable testimonial to the excellence of good concrete construction. The concrete frame, stripped by fire of all contents, window frames and floor coverings, is standing in every instance but one, with very little injury to the ceilings, although minor cracks developed in the beams and girders over the reinforcement and forced off the 2-in. concrete covering in some instances. There is hardly a perceptible sag or lean except where the columns have given way. Had the concrete floors been unable to withstand the heat, there would undoubtedly have occurred an entire collapse of the buildings.

All but two of the concrete buildings will be ready for installation of equipment after washing out with a hose and placing new window sash and glass, which will be of steel and wire-glass.

The straight-rodded reinforced concrete columns (without stays or hoops) on the third floor of one of the buildings and in the lower story of another are badly spalled and cracked, due probably to the fact that water was thrown on them while red hot. In a few instances they have buckled and broken in an unprecedented manner, showing that columns of this type are dangerous in a hot fire. Aside from column design, expert analysis will probably show that the design of the buildings, most of which were constructed about five years ago, was not all that would be considered good practice today.

W. M. Kinney, Associate Editor

IT is with a great deal of pleasure that this magazine announces a new member of the board of Associate Editors: William M. Kinney. As Engineer-in-Charge of the Inspection and Information Bureaus of the Universal Portland Cement Co., since last spring, Mr. Kinney has contributed much valuable material to this magazine. His name has appeared with frequency over important discussions in the Information and Consultation Department. For some time previous to last spring, Mr. Kinney was principal assistant engineer in the Bureaus of which he is now in charge. Of his capacity and willingness to serve in the cause of good concrete, you already know. He is in a position to observe important researches into the proper uses of Portland cement, and is in touch with field and factory operations of wide variety. He has a large and able staff and his and their opinions will be, as they already have been, distinctly worth while.

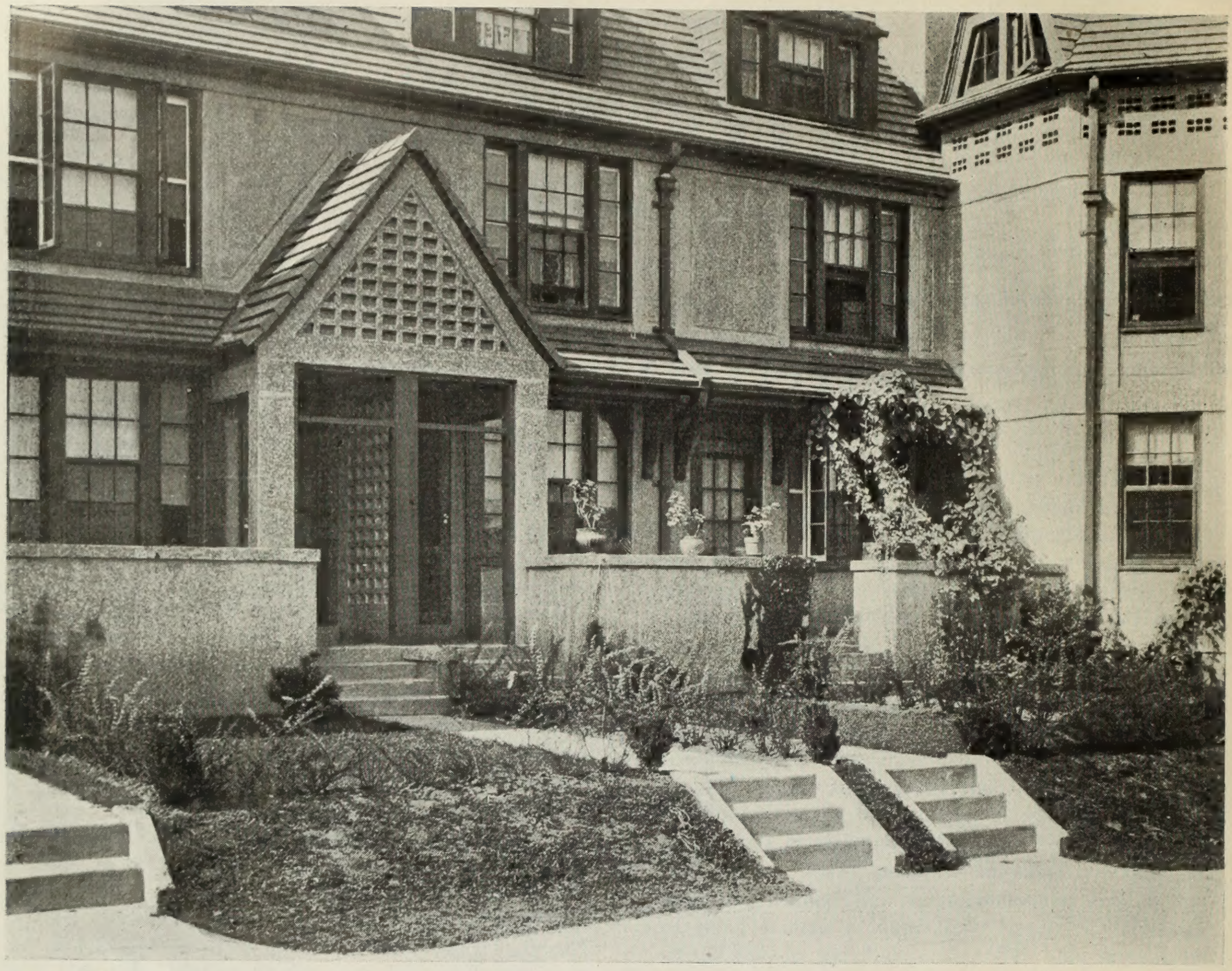

Fig. 1—Detail of Concrete House in Group II, Erected for the Sage Foundation Homes Co. Under Mr. Atterbury's System of Hollow Sectional Concrete Construction

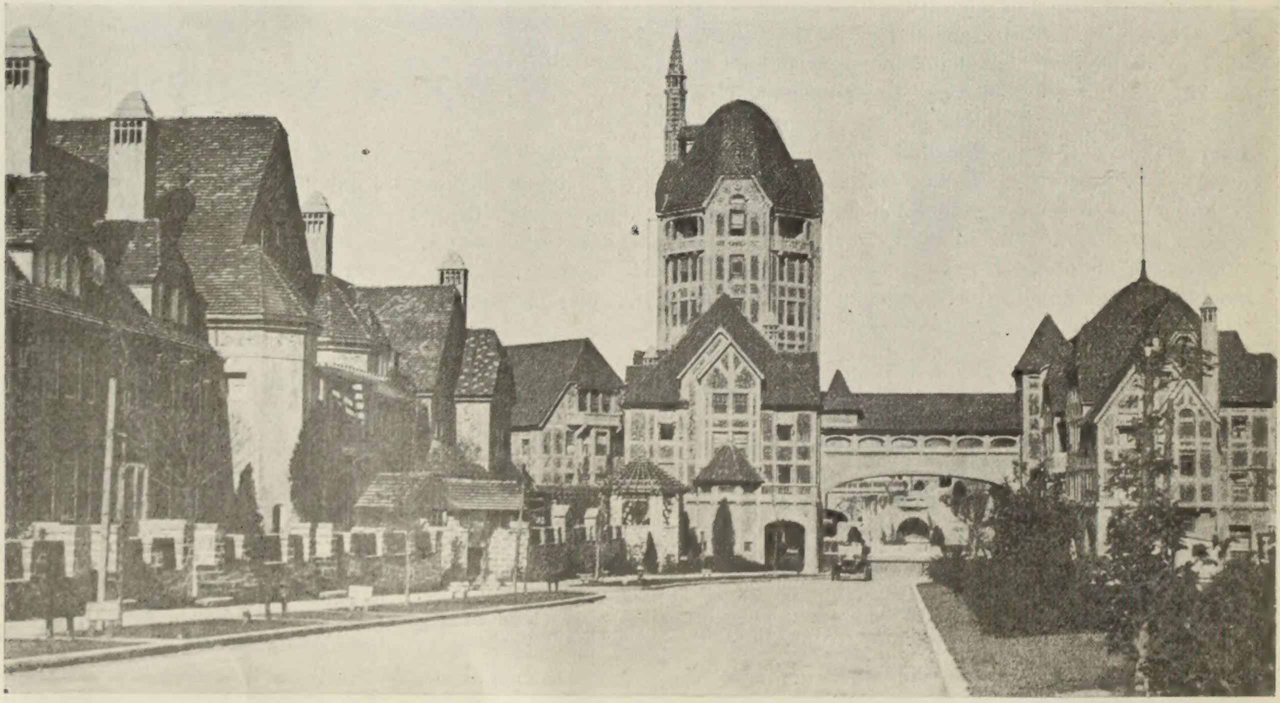

Fig. 2—View of Tower and Business Center at Forest Hills Gardens

Houses at Forest Hills Gardens—Pre-Cast Hollow Concrete Floor, Wall and Roof Units and Exposed Aggregates[1]

By Frederick Squires[2]

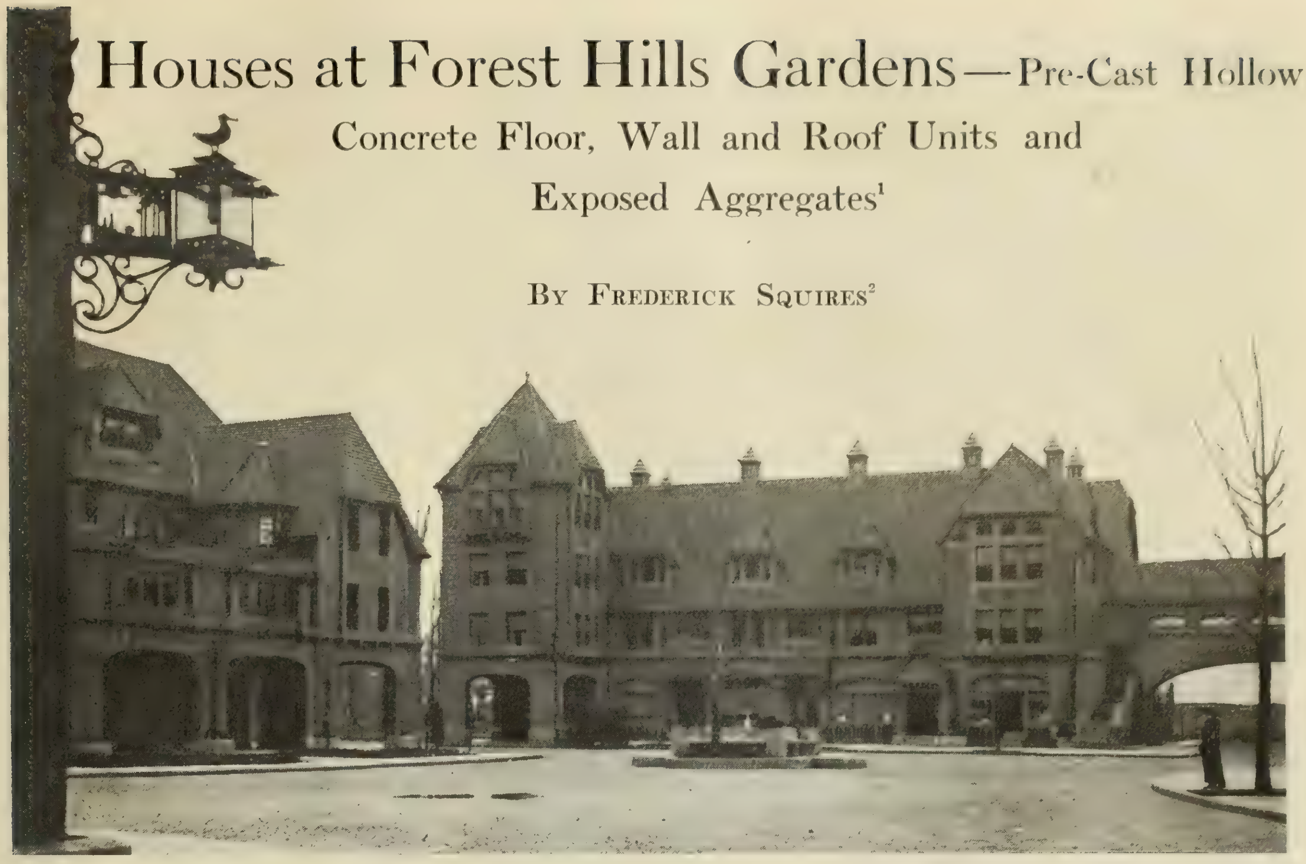

Fig. 3—Plaza at Business Center of Forest Hills Gardens, Long Island

A house of pre-cast concrete block is no new thing, in fact, concrete was first of all used for residences in the form of small pre-cast block to be set by hand. The size of the building unit has usually been predetermined by some peculiarity of its manufacture, brick, for example, being small because only small pieces of clay can be burned successfully. In other cases where there is no such limitation in manufacture, the size is made convenient for handling both while being made and while being used, as in the case of hollow tile, stone and wood. This is the only reason for the size or rather the weight of the average concrete block, one of whose dimensions is in most cases a wall thickness. Steel is so heavy in proportion to its size that almost all its structural sizes are too heavy to be handled without the use of machinery, but for all high structures its obvious advantages far outweighed this handicap. Grosvenor Atterbury, in the development of Forest Hills Gardens for the Sage Foundation, has applied the methods of handling steel to pre-cast concrete block for certain of the dwellings.

As monolithic concrete construction advanced, it became increasingly customary to pre-cast certain of the structural parts, beams at first, but finally even columns and slabs, although often the slabs were poured in place after erecting the frame work. Ernest Ransome perfected this method for commercial work, and meanwhile Mr. Atterbury, a New York architect, was conducting scientific experiments looking as to the use of large pre-cast concrete slabs for floors and walls of dwelling houses.

These studies began about 10 years ago, and for the last five or six years the experiments and demonstrations have been conducted under

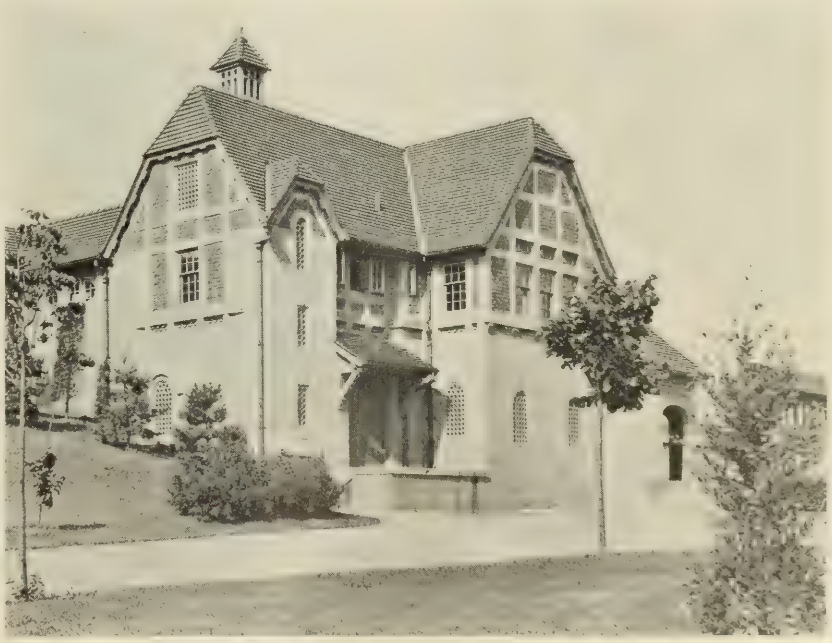

Fig. 4—View of Railroad Station Showing Pre-Cast Concrete Grilles, Brushed Concrete Stucco Walls, and Half Timber Applied in Situ Over Terra Cotta Blocks

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[1] For a statement of the original program of Grosvenor Atterbury, architect for the Sage Foundation, see *Cement Age*, Dec., 1910, p. 315. Data for the present article were supplied by Mr. Atterbury.—Editors.

[2] Architect, N. Y. C.

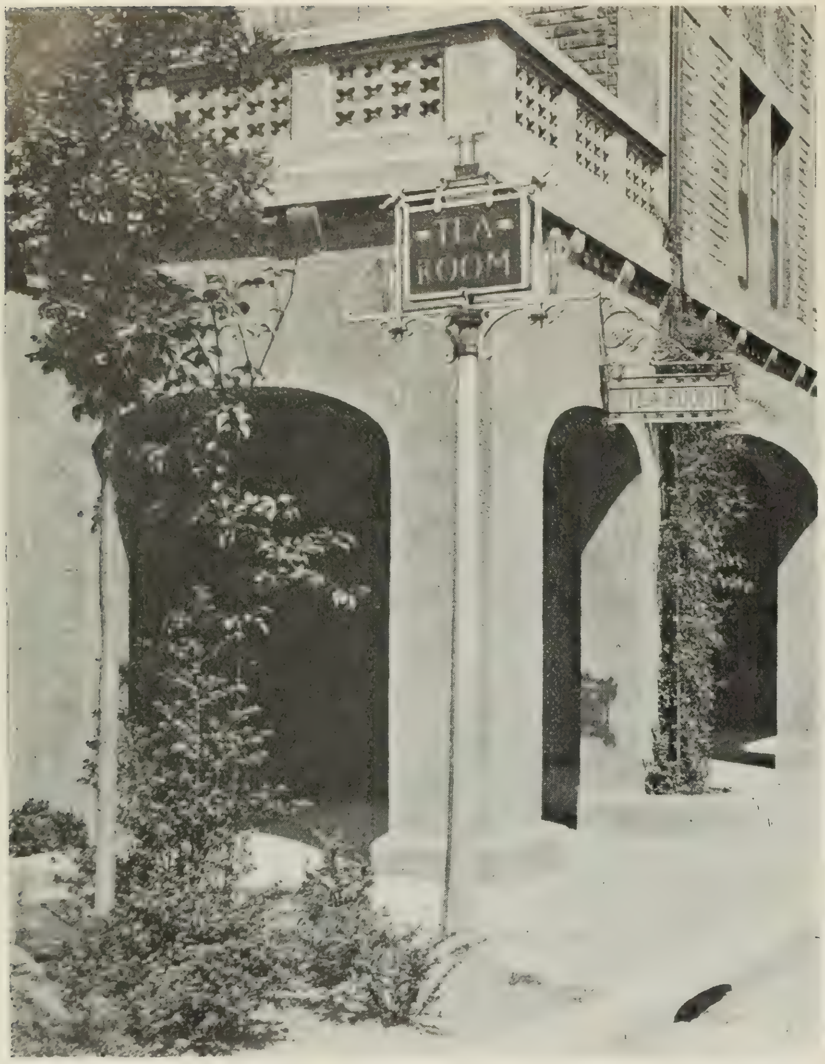


Fig. 5—Detail Showing Texture of Brushed Concrete Work Applied in Situ with Colored Agrregate

appropriations made by the Russell Sage Foundation. As the result of this work Mr. Atterbury has developed a system of building construction whereby mechanical devices have made practicable the use of pre-cast concrete block many times larger than the old concrete hand unit.

It may be worth while first to get a broader view of the interesting place of which this group of pre-cast slab houses forms a part. The very introduction to the place, the railroad station, usually the most distressing feature of any American town, is at Forest Hills a place of excellent design, stucco covered and largely built of concrete. Seen from its platform is a picturesque new-old quadrangle, all the buildings forming it tied into a unique composition by bridges, and its interest magnetized by a tower, a structure steel framed but floored with concrete.

These buildings are concrete paneled, with fields of brick work; the tone of the concrete is obtained with an aggregate of broken roof tile, which corresponds pleasantly in color with the red tile roofs. The pierced designs of the chimney tops and the exquisite texture of the concrete fleche finishing the tower are particularly worthy of attention. Nowhere is the trademark of good taste more clearly printed than in such uses of a much misused material. The views of this quadrangle show, in the sidewalk arcades, how easily overhanging stories may be accomplished in concrete construction. Passing through the courtyard and looking back on it from the main road, there is a scene for picturesqueness not equaled anywhere in America and for an artistic use of concrete unequaled in the world. Pierced chimney tops, beautifully toned stucco, concrete paneled walls, fountains, telephone poles, balustrades, teahouses, ramps, fleches, balconies, all executed with wonderful charm in a material for which a great English architect studiously denied the possibility of artistic expression. For years in New York City Italian and Greek ornamental plaster makers have been casting lovely concrete images and engineers have been designing concrete buildings. Mr. Atterbury has brought the two together.

Much of the beauty of the group cannot be shown in the illustrations, the colors of the exposed gravel aggregates and the crushed red tile playing an important part in the general effectiveness. There is a warmth of hue which has been attained only occasionally in concrete work. The

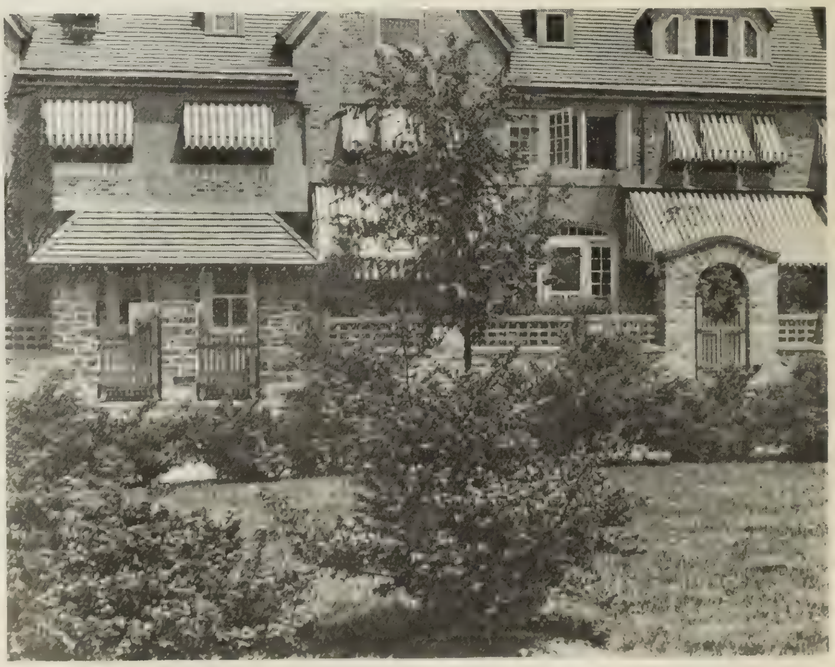


Fig. 6—Portion of Group VI, Forest Hills Gardens, L. I.

Shows in upper stories concrete half-timber work composed of pre-cast hollow sections made in the factory, reinforced and filled in erection; terra cotta block and brick panels inserted, also brushed concrete grilles, copings on terrace walls, and gateways.

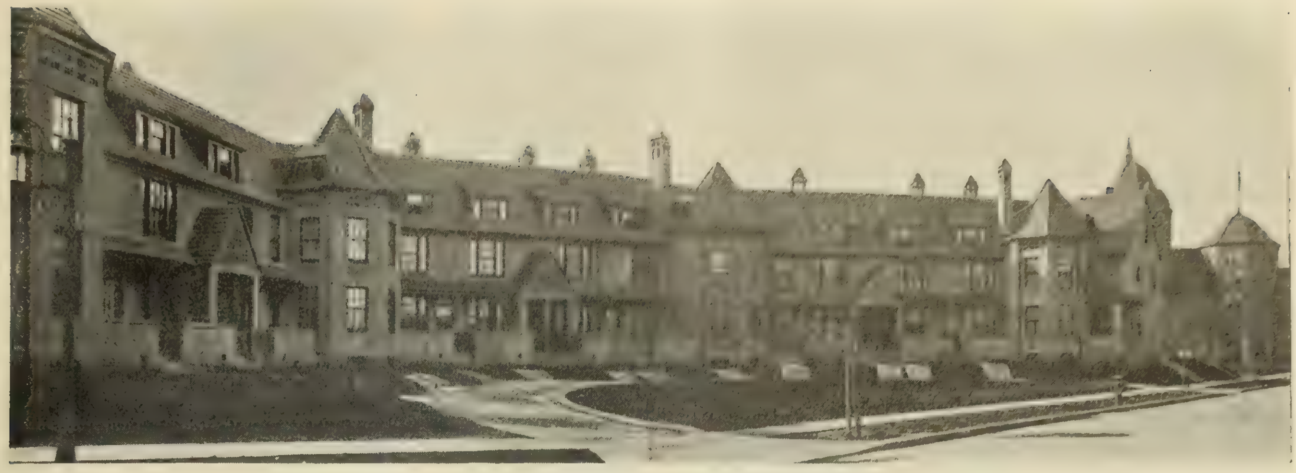


Fig. 7—Group II, Forest Hills Gardens, L. I.

Of this group the 10 small houses were erected under Mr. Atterbury's system of hollow sectional concrete construction, the four larger ones being composite in type, with roofs, floors and partitions of various fireproof methods of construction

reproductions from photographs do show texture, however. Even the concrete sidewalks are obviously not "cement sidewalks" as the aggregates have been exposed.

While the general appearance of the main groups is similar, in that almost all of the exterior walls are paneled with concrete bands or half timber, which represent the horizontal and the vertical reinforcements in the walls, they are in some cases formed in the ordinary way by using terra cotta block reinforced and covered with concrete stucco on the exterior, the intermediate spaces being filled in with a veneer of brick; while in other cases it is a true reinforced concrete skeleton building in which panels are formed by the erection of pre-cast tubular concrete timbers reinforced and filled after erection at the building. This method of construction—the employment of what may be called permanent molds—is the intermediate step between the ordinary *in situ* process of concrete construction and the factory-made sectional system illustrated in the figures of the group of 14 houses erected and now occupied for something over a year at Forest Hills Gardens.

It will be best to preface the description of this group of pre-cast houses with a visit to the factory where the units are made, as is shown in the accompanying illustrations (beginning Fig. 13). Fig. 13 shows the interior of the casting shed or head house, from which an overhead electric crane runs out through the storage yard, as shown in Figs. 14 and 15. These illustrations show the wall, floor and other sections stacked ready for transportation on small cars running over an industrial railroad to the building site. Fig. 16 shows a car loaded with its maximum load of 8 large wall sections approximating 1½ tons each in weight. These cars were drawn by mule very readily and the sections picked off by the erecting crane, shown from various points of view in the succeeding illustrations.

The entire process—manufacture, transportation and erection—involves only three necessary handlings of the units. After being poured from the mixer into the steel molds and partially hardened, the sections are lifted out on false bottoms by the electric crane and finished while still green; as soon as they are hardened they are lifted off the false bottoms and placed on the transportation cars in the storage yard, to be handled for the third and last time when they are picked off the cars and set in their proper places in the building by the erecting crane.

The actual time during which labor is put upon these sections, from the gravel bin to their completion in the building, amounts to less than five

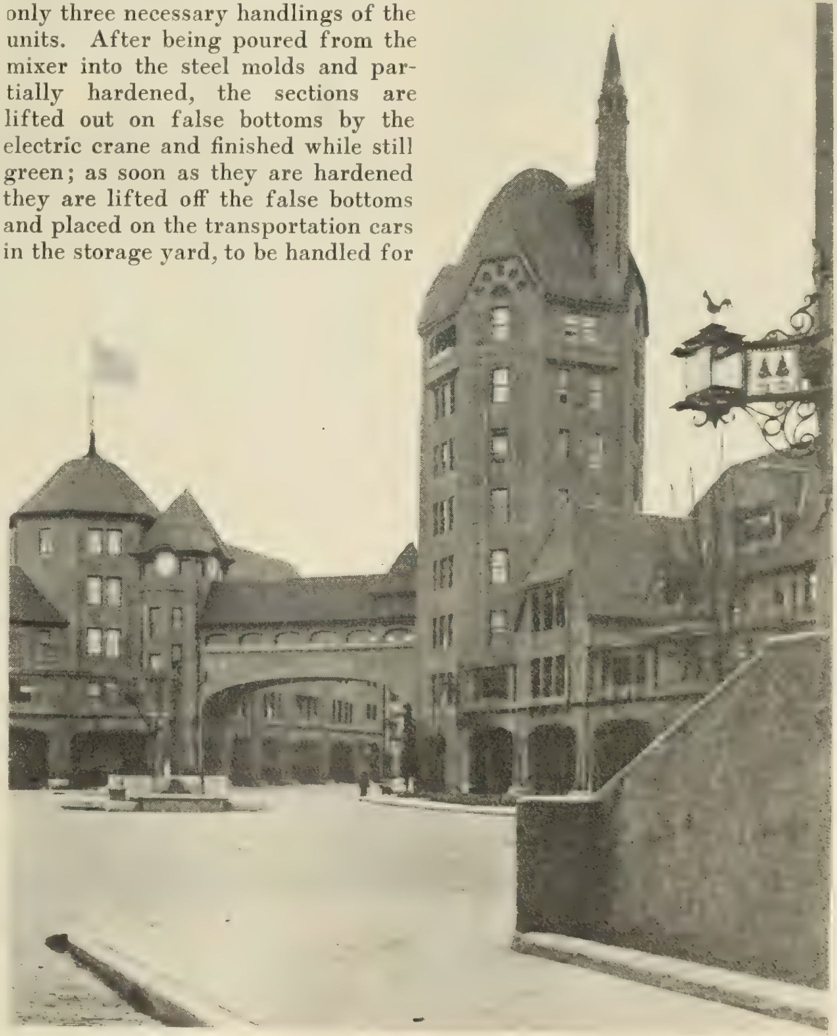


Fig. 8—Detail of the Town Center, with Tower and Arched Street

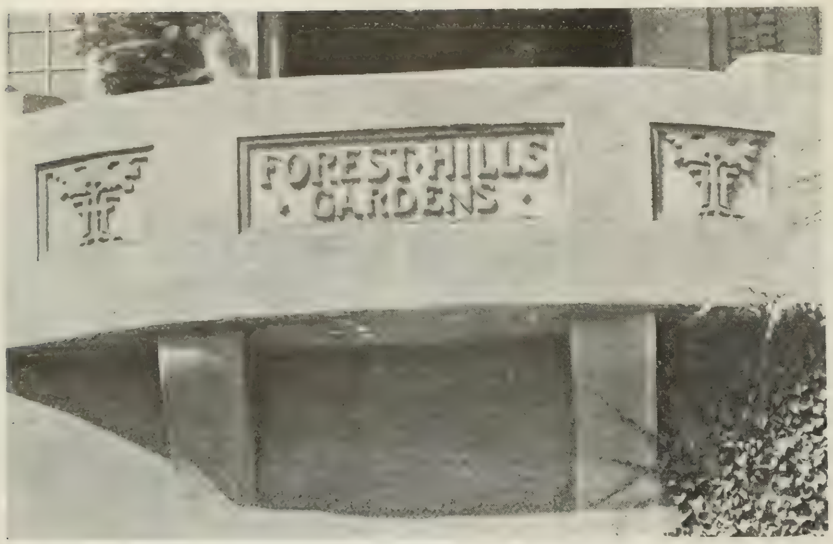


Fig. 9—Balcony Showing Use of Pre-Cast Decorative Brushed Concrete Panels of Colored Aggregate and Colored Concrete Mosaic Backgrounds

hrs. The minimum time for seasoning, during which no labor is put upon the block, is approximately three days for the wall units and one week for the floor sections. Replacements were actually made and set in the buildings within three days at Forest Hills and 20-ft. floor sections have been handled one week after casting. A longer time, normally, should of course be allowed for manufacturing and seasoning. But with a proper plant and good conditions the erection work can begin within two weeks after the commencement of manufacture. This includes the time necessary to finish completely both the exterior and the interior of the wall sections, for the system contemplates the omission of lath, plaster and interior trim, the section being molded on the interior side so as to form panels in the walls of the rooms, as may be seen in Fig. 27 where the block are standing ready to be leveled up on the floor of the building.

The process of erection is designed so as to eliminate as much as possible the scaffolds, temporary supports and the waste time consequent upon the ordinary construction, where one trade follows another and is more or less dependent upon prompt cooperation.

In this operation the time occupied in lifting the block from the transportation car and placing it in position in the buildin, trued up and wedged ready for grouting, averaged about 20 minutes for each section. As a matter of fact, owing to the shape of the group, it was impossible to keep the crane busy, since the greatest number of houses erected at one time was five. On a straight group where the crane could move readily up and down the track, without having to be turned as was the case in Group II, the speed of erection could undoubtedly be doubled. Even under the existing conditions the records show that in the first operation, covering three small houses, the concrete shells were completed and ready for the finishing trades—plumbing, heating and painting—in six weeks from the laying of the foundations. This was at the rate of a house in two weeks, and was accomplished by laborers who, with only one exception, had never before seen the system in operation.

The second group of four 13-ft. houses was erected in five weeks; or at the rate of a house in nine days.

As the curing process occurs in the factory before beginning erection, the speed of erection and completion under this system can be pushed to its economic limit. It is evi-

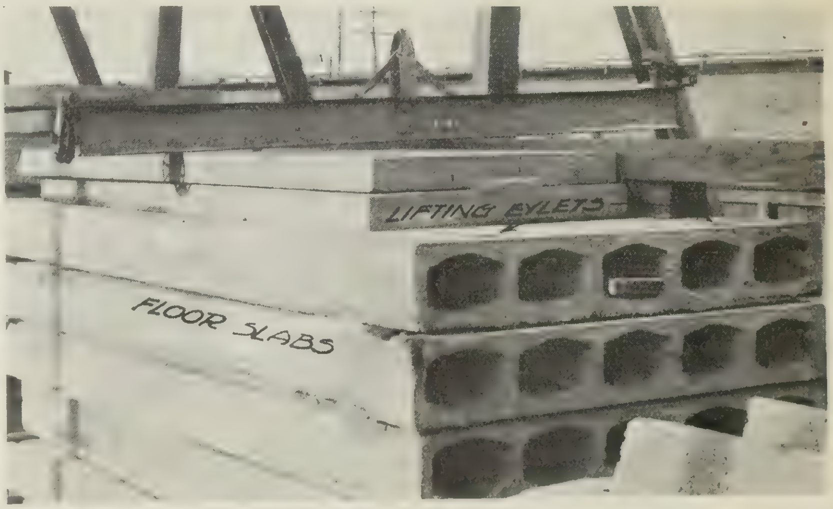
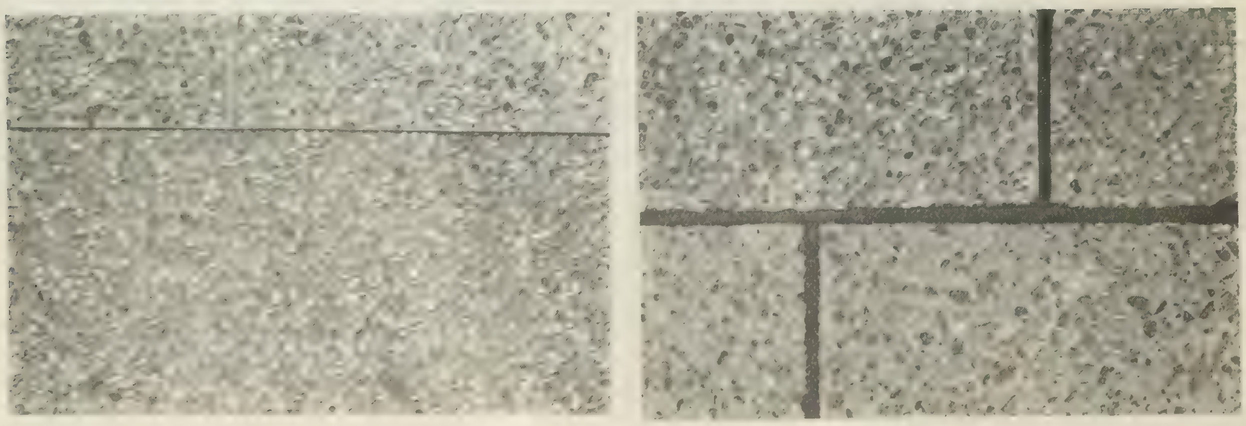
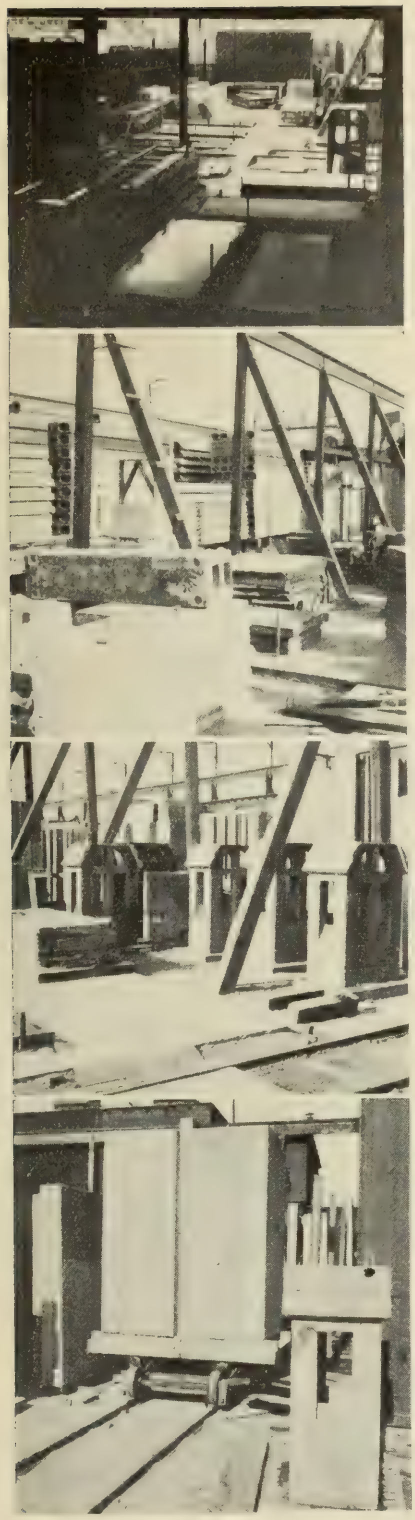


Fig. 10—Floor Slabs in Storage Yard of Factory

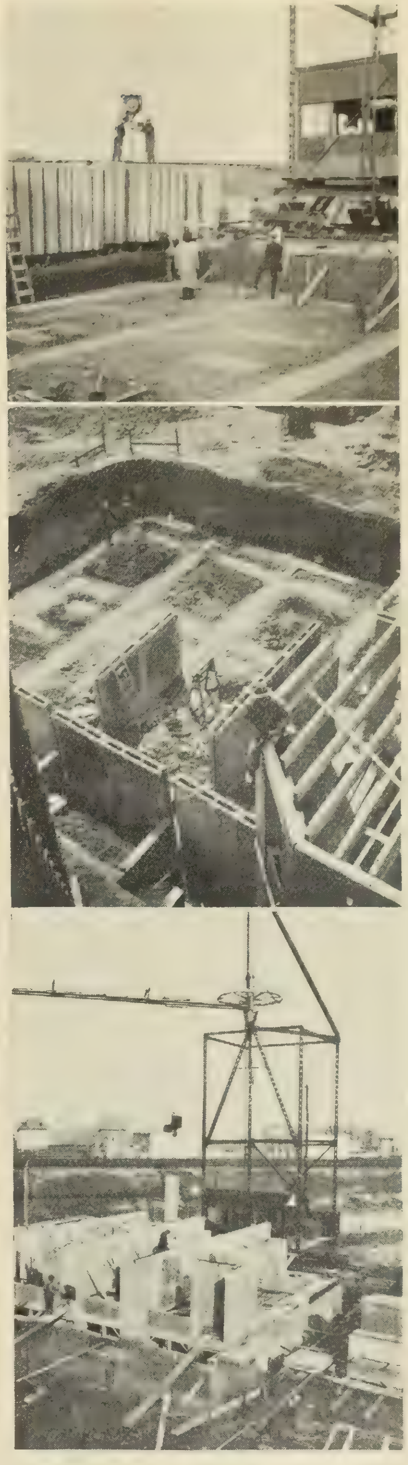


Figs. 11 and 12—Wet Process Brushed Concrete Block Showing Various Shades of Aggregate

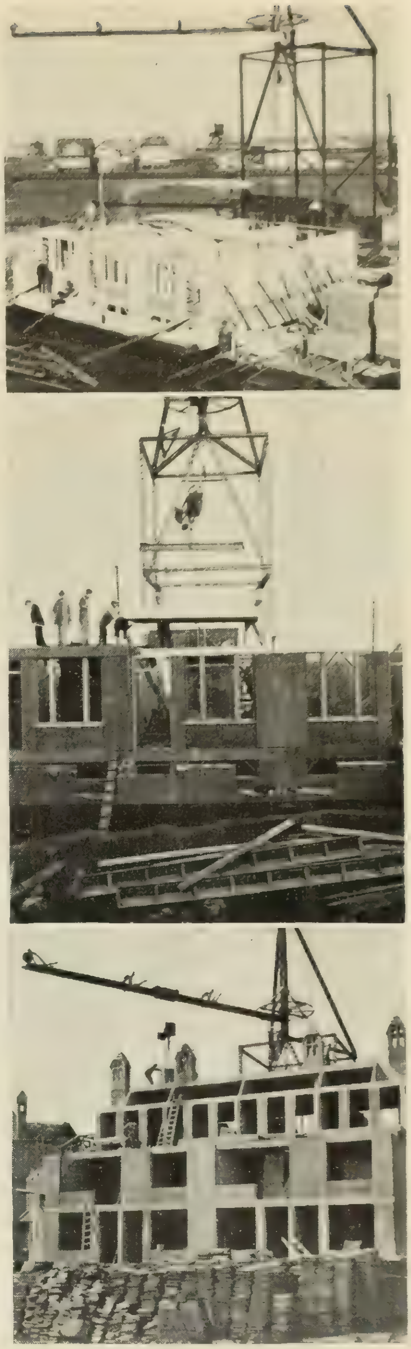


Figs. 13, 14, 15 and 16—Views at Factory for Pre-Cast Units at Forest Hills

(13) Floor slabs in molds in foreground; yard in background; (14) units piled in yard; (15) chimney caps in yard; (16) wall slabs on cars for transportation to building site



Figs. 17, 18 and 19—Successive Views of Building Operations with Crane Placing Units



Figs. 20, 21 and 22—Detail Views of Pre-Cast Unit Houses Under Construction

dent from the records of the demonstration at Forest Hill Gardens that sectional houses in groups can be erected at the rate of one a week and completed by the finishing trades, ready for occupancy, in two months from the first delivery of sections at the site. In the buildings at Forest Hills, which had to be finished to correspond with the high class structures adjacent to them, seven or eight weeks were spent in finishing and decorating the interiors.

While in a majority of the houses the interior surfaces of the walls are all of concrete, as before explained, certain of the houses are plastered directly on the wall sections and have floors constructed of pre-cast concrete beams, as clearly illustrated in Figs. 29 and 30, which show in contrast to Fig. 28 where the hollow sectional floor is illustrated. These concrete beams had on top and bottom a surfacing of a cementitious nailing mixture into which floors and lathing were nailed. The same product of the factory was used on the roofs as a nailing surface to receive the tile.

Among other by-products of the demonstration work at the factory there has also been developed a hollow wet process concrete block, with a brushed surface of ordinary hand unit size, for use in buildings not permitting the introduction of the

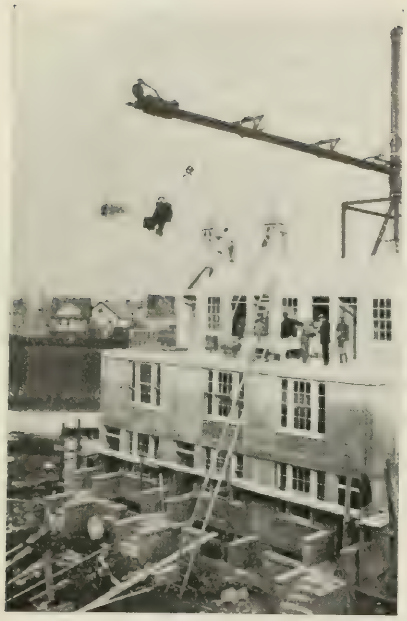


Fig. 23

large and undoubtedly more economic standard sections.

While the factory has thus been used for all the various products employed at Forest Hills Gardens, the plant, as was to be expected, has not justified itself commercially through the products utilized so far in the buildings erected with pre-cast units.

So much of the work done has been pioneering, with such large to be specially made and remade and in various undertakings which were purely experimental, that Mr. Atterbury's achievements in the Sage Foundation undertaking are more a contribution to the science of building with pre-cast units than a successful investment in the immediate work described. Mr. Atterbury believes that in spite of adverse conditions the commercial possibility has been demonstrated, so as to be available in further undertakings which are of sufficient magnitude to warrant the "wholesale" methods involved.

One of the preliminary decisions arrived at in connection with the manufacture and use of large wall and floor units was this: In order to make it practicable to adopt a really scientific and economic design, all units were to be cast and subsequently handled in the same position as that in which they were to be put under stress in the building itself. The floor units were thus made horizontally and the wall units were cast vertically. The molds for the wall units were in a pit and were faced by the use of a dividing plate with the special facing mixture on one side, backed up on the other with the regular mixture. This in all cases was poured wet. The molds are of steel, the sides hinged at the bottom and adjustable for different thicknesses of slab. Both floor and wall molds were equipped with collapsible or tapered cores, which were steam heated for rapid curing of the wet mix. By this method it was found actually possible to remove a one-ton wall slab vertically from the molds in two hrs. after pouring but this was obviously undesirable as the great heat required "cooked" the concrete so as to deprive it of most of its strength. In practice each mold was never used more than twice in 24 hrs. Floor slabs were usually 14′ long, 5′ wide and 10″ thick. Wall slabs were usually 8′ 6″ high, 6′ wide and 9″ thick cored and having 2¾-in. webs and outer and inner shells 1½″ thick.

In the earlier demonstrations the average wall sections weighed a little less than one ton, being the equivalent of from 1,200 to 1,500 brick laid in an 8-in. wall. Experiments, however, showed that still greater economy could be affected by increasing the size of the units, which now run from one ton to three tons in weight, the practical limitation imposed on their size really lying in the design of the structure itself and not in any mechanical difficulty of manufacture, transportation, or erection.

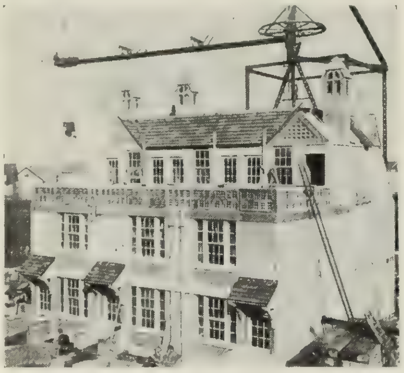


Fig. 24

Floor slabs weighing 3½ tons, 11″ thick, 6′ in width, and 20′ in length have been successfully handled and tested; although in the 14 houses recently erected at Forest Hills Gardens the houses did not require floor sections more than 14′ in span. Obviously, the success of this idea from a mechanical point of view depended upon the substitution of high power machinery for ordinary hand labor, the key to the situation being an electric crane and derrick.

An account of some of the earlier experiments and demonstrations appeared in the *Cement Age* for Dec., 1910, in an article entitled "Studies in Economic Construction," in which the first experimental house to be erected of such hollow factory-made concrete sections was described. The group of houses at Forest Hills Gardens, the construction of which is illustrated beginning with Fig. 13 later in this article, is a further development of this same system; although the group itself is not entirely standardized and contains houses of composite type with various kinds of constructional elements introduced for experimental purposes.

Surfaces for the interior walls of the houses were brushed over with grout after removal from molds, to fill all pores and pin holes and were then rubbed down to a smooth finish and subsequently decorated. Exterior surfaces in some cases with special facing mixtures, and sometimes with ordinary gravel mix, were scrub- a few hours after casting—the exact time being governed by weather conditions. This scrubbing was done with stiff fibre or wire brushes at a cost of 1 ct. per sq. ft. Power brushing machines were tried but discarded. At the age usually of two das. the scrubbed surfaces were acid washed, to brighten the aggregates.

Floor and wall slabs are shown in the illustrations and their section is well illustrated in Fig. 28 where the nailing strips, for securing wood floors and the metal eyelets for attaching the derrick chain hooks are indistinctly shown. The under sides of the floor slabs were cast smooth to be exposed, but they were finished with heavily stippled paint, after erection when the interiors were finished and decorated. The cores are vertical in the walls and the lifting device for handling them operates through them so as to lift the sections from the bottom. There are two patterns of wall block in each story, a slab the full clear story height and a short panel from floor to window sill. Each slab except for corner use is tongued on one closed side and grooved on the other.

These characteristics are shown in Fig. 22.

In the regular 13-ft. houses, which were the only ones of really standardized construction, each house, including its terraces and walls, contained approximately 140 sections of all kinds, the total in the entire group of 14 houses approximating 2,000; all of these were manufactured, transported and erected with an astonishingly small loss by breakage.

Building operations, in this particular case on a cleverly planned crescent-shaped group of attached houses, are shown in a general construction views.

The electric derrick, which is

(Continued on page 53)

Stucco in Suburban Architecture—Notes on Ogontz Hill, Philadelphia

By Oswald C. Hering, A. I. A.[1]

In order to establish any industry on a sound, paying basis, there must first be a clear and well defined purpose for the manufactured article. In the course of its development other factors will arise which may materially increase or decrease its usefulness, and upon whether or not these factors are recognized and given due consideration hangs in a great measure the success or failure of the undertaking. The writer will attempt no recital of the history of the cement industry. Its marvelous growth in the last 20 years is a matter of common knowledge, although not so the many and varied channels through which its product has been led into useful accomplishment within this comparatively short space of time. There seems, however, to be one avenue radiating from the center of activity of the cement industry that does not present the customary scene of busy and bustling trade. This avenue has been hardly more than "staked out" and "opened up," and a little way ahead the sprouting weeds testify to the infrequent use made of a thoroughfare whose dormant charms still await an awakening touch. Unlike the other avenues this one leads to Beauty. The use of cement employed to make articles of beauty is an industry as yet in a state of puling infancy. Architecture and decorative art in which cement is used as an ingredient with other materials to form objects of stucco or concrete have produced but few handsome objects. Compared with what has been accomplished in purely utilitarian fields, the field of esthetics may be considered almost barren of cement products. Yet the possibilities for beauty in form and color of concrete and stucco have almost no limitations and it is the writer's belief that the time has now come for a few intelligent crews to get to work, and materially extend the Avenue of Beauty. The chief reason that so little has been done in the past to push forward its construction is the lack of intelligent co-operation of the minds concerned.

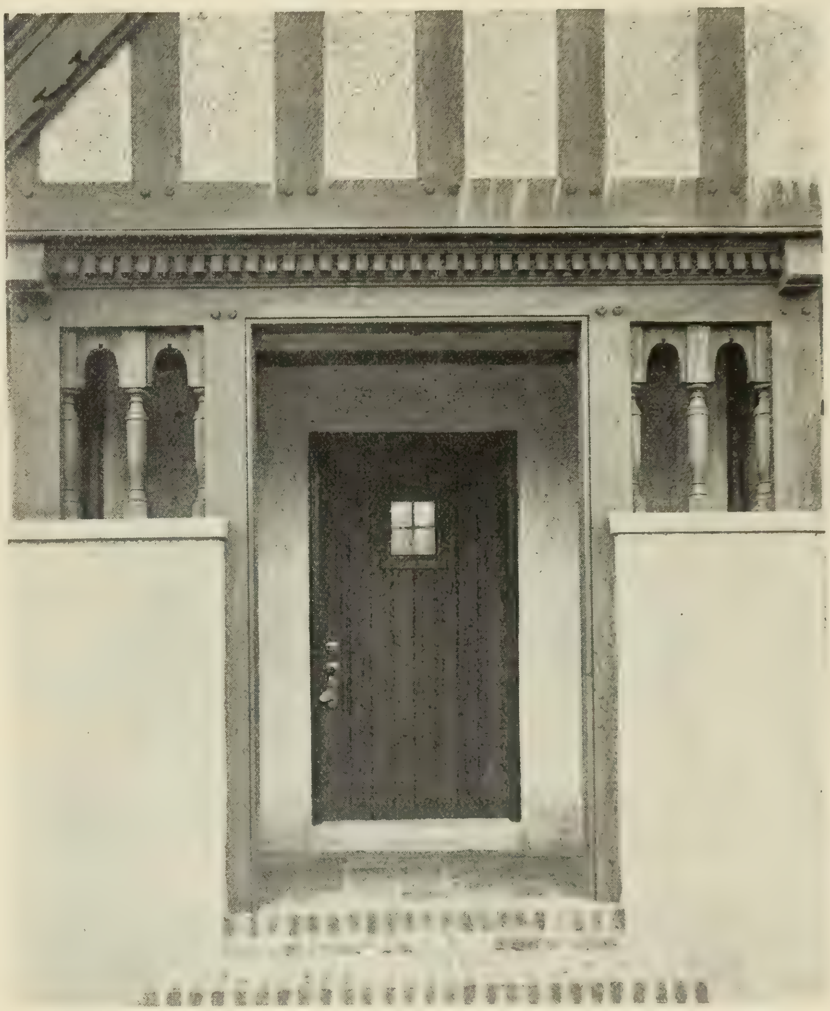


Fig. 1—House of Hollow Tile and Half Timbers at Ogontz Hill

The walls are "dry" dashed as described in the text, with white, yellow, pink and black marble chips. The half timbers and other wood parts are chestnut stained a weathered gray. The roof is covered with slate graded in size and thickness and variegated in color

The same minds which so successfully developed the various utilitarian avenues began the construction of the Avenue of Beauty and at once struck an impassable barrier. They had no ability to conceive the beautiful. On the other hand, swayed by his inherited instinct for dealing exclusively with that trio of mediums, wood, brick and stone—the "three r's" of his profession—and still wary of his late acquaintances, iron and steel, materials whose unfamiliar and disturbing nakedness he has been quick to clothe with stone, terra cotta, or other decent dress, the average architect shies at the aspect of stucco and concrete, as some horses still shy at the automobile.

Architects are as a class conservative for the reason that their art is the expression of the habits of the people whom they serve. The individual does not alter his mode of life from day to day nor from year to year. A nation may change its government over night, but the forces that effect a revolution have a gradual growth. Architects have therefore viewed with suspicion, and even dislike, building materials that from their nature require the abandonment of certain forms of design which they have hitherto regarded as basic, and which call for the modification of methods and revision of rules that have been for centuries fixtures in the art of architecture.

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[1] Archt., N. Y. C.

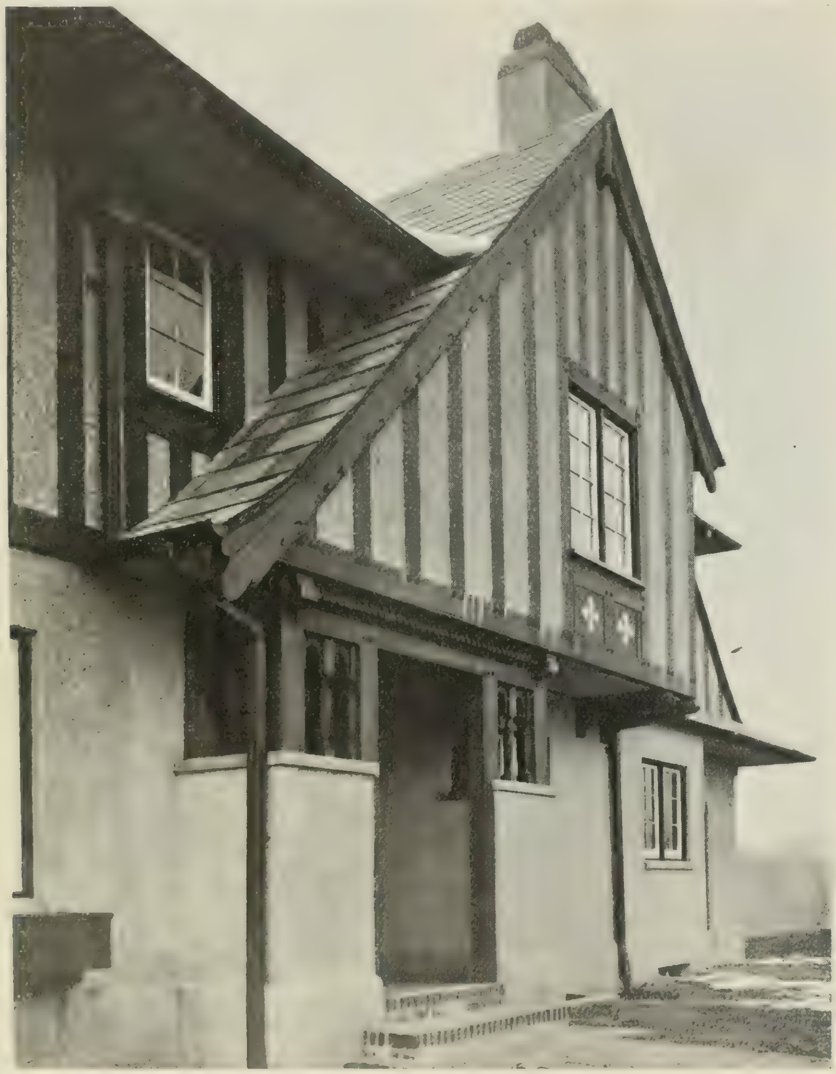

Fig. 2 Larger Detail of Same House Shown in Fig. 1

There is but one way to obtain objects of beauty in stucco and concrete and that is by the co-operation of practical minds, versed in a knowledge of the physical properties of these materials, and imaginative minds, capable of picturing their esthetic possibilities and willing to draft and mold them into objects of beauty. Manufacturers of cement and concrete products must invoke the aid of the architect and the sculptor if this new avenue of development is to be continued with the degree of speed that its promise of beauty and profit demands.

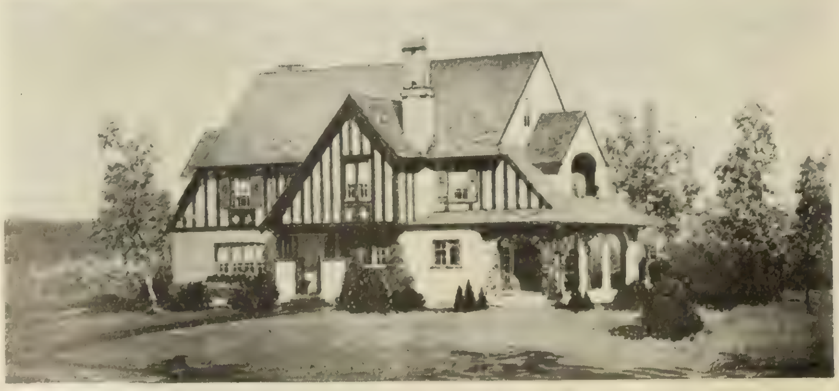

Fig. 3 Sketch of Proposed Completed House As Illustrated from Photographs in Figs. 1 and 2. Oswald C. Hering and Douglas Fitch, Architects

One of the readiest means at hand is the more frequent use of stucco in the domestic architecture of suburban communities, where opportunities abound for the employment of pleasing effects in texture and color and this being a "House Building" issue an endeavor will be made in the pages to follow to point a way in which stucco may be so employed as a building material as to appeal with greater force than heretofore to the imagination and good sense of the prospective home builder.[2]

The history of architecture shows us very clearly that the housing of man has with few exceptions been accomplished with the materials nearest to hand. Common sense should dictate a durable form of construction, and good taste will suggest an outward appearance that will be in harmony with the character of the land. Fascinating as are the old wooden houses of New England, they are not in sympathy with the present day civilization. To expend such care, energy and money upon a structure that begins to deteriorate with comparative rapidity the day it is begun, that involves continual care and expense to retard its decay, and that may vanish over night in smoke and flame, when a durable and lasting monument of equal beauty may as readily be had, would indicate that sentiment had overcome good judgment. Wooden buildings cannot keep pace with the march of progress, and it indicates no lack of respect for these one-time giants of Colonial architecture to suggest that their propagation cease.

The day of wood for the exterior covering of an all-year-round house has gone by, and stucco has largely taken its place. Curiously enough, stucco lends itself with readiness to almost any architectural design that may be suited to the particular environment. That the lay of the land, and the needs and characteristics of the inhabitants determine the style of architecture to be employed as an undisputed fact, but it is no exaggeration to say that there are few if any instances in the suburban and country communities of America where sand and gravel prevail, in which stucco and concrete cannot be fittingly employed to express the true spirit of the neighborhood.

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[2] For much of the material used in this article in describing the various architectural developments of stucco, Mr. Hering has drawn freely from his book: *Concrete and Stucco Houses*, McBride, Nast & Co., N. Y. C.

Both stucco and concrete are adaptable to any form of plastic design, and each lends itself readily to modifications of almost every style that could be conceived as suitable in respect to our national inheritance. We are mainly a mixture of the Anglo-Saxon, Germanic, Gallic and Romanic races, and our houses may properly reflect a suggestion of English, German, French and Italian styles past and present. All of these are readily expressed in terms of stucco and concrete.

Stucco has a great deal to recomment it in house construction, but it has also some conspicuous drawbacks. Stucco is much like the little girl—"when she was good she was very, very good, but when she was bad she was horrid." When properly made and applied it is durable, inexpensive to maintain, a warm covering in winter and a cool one in summer, pleasing to the eye and susceptible of an unlimited number of variations in texture and color. When badly or carelessly made and applied, no material could be worse, for if it does not fall off entirely it will peel off in sections, bulge, crack, absorb water, spot, streak and take on either a dull cheerless gray or a medley of tints, as the ill-chosen mixture or poor workmanship may determine. Its so-called defects are usually traced to the ignorance or carelessness of the men who specify and handle it, if not to a deliberate swindle.

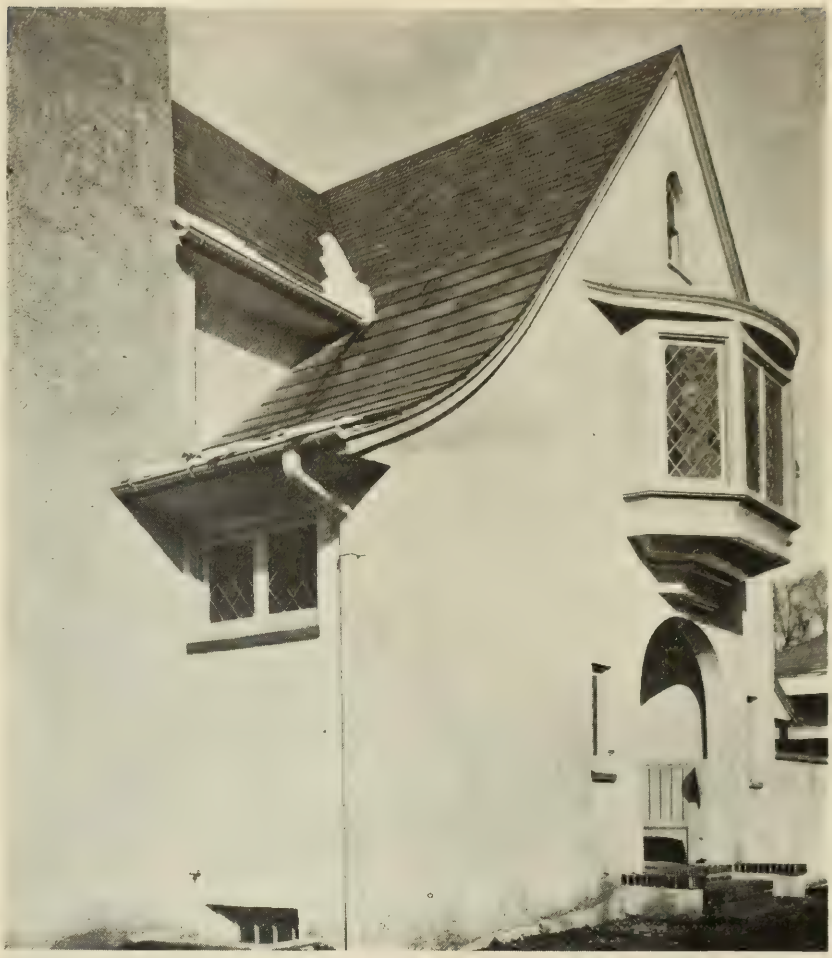

Fig. 4—House of Hollow Tile Stuccoed

The rough cast finish has been tinted a French yellow and the house roofed with slates graded in size, thickness and color, beginning at the ridge with small thin buff colored slates, gradually increasing in width, length and thickness and merging into dark gray and light gray colors towards the eaves

From an artistic standpoint, perfect uniformity of shade in stucco is not essential or even desirable. A certain amount of blending variation in tone is pleasing to the eye, while a perfectly even color lacks character. Of course an abrupt line of demarcation such as would be produced by a radical change in the mixture, unclean material, the difference in workmanship of one man and another or from a change in the weather during the operation, is not desired. The softening tones which age will give to the stucco improve its appearance, and consequently there are many instances in which an unevenness in color of the stucco upon the completion of the work need occasion no quarrel with the contractor. The glory of brick and marble lies in the subtle coloring acquired with age, the gife of time and its chemical agents. The modest shingle owes its sole claim to beauty to its property of weathering a demure gray, and to a slight deposit of dust and grime is due a large part of the "character" of Colonial columns and clapboards. Nature is the cleverest of all beautifiers and she may generally be trusted to enhance rather than despoil the beauty of any building worthy of her attention. Blemishes turn into beauty spots and discolorations become picturesque blendings of harmonious tones. The conception of the architect should determine whether or not the "blemishes" and "discolorations" contribute to or detract from the completed picture.

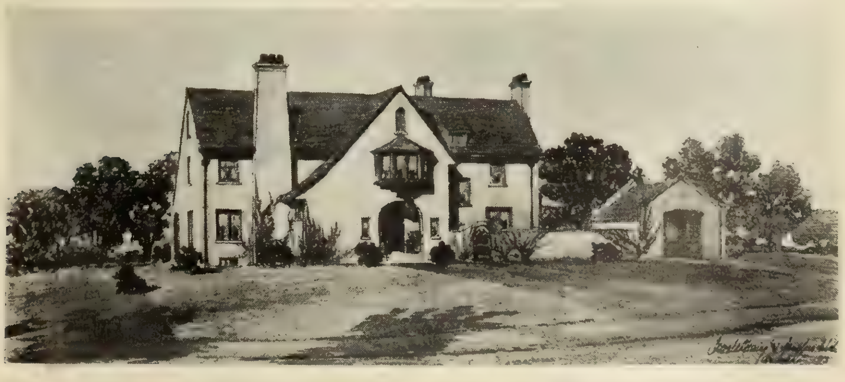

Fig. 5—Sketch of Completed House, a Detail of Which is Shown in Fig. 4. Oswald C. Hering and Douglas Fitch, Architects

When stucco of a decided color is desired (aside from painting it) only mineral colors should be employed, and these had better be used sparingly and limited to carbon black, ochre and red oxides of iron and their combinations. It should be borne in mind that coloring matter reduces the strength of the stucco. Very pleasing shades may be obtained, however, without the admixture of pigments by using an aggregate of crushed stone, brick or marble, and white or yellow sand or gravel mixed

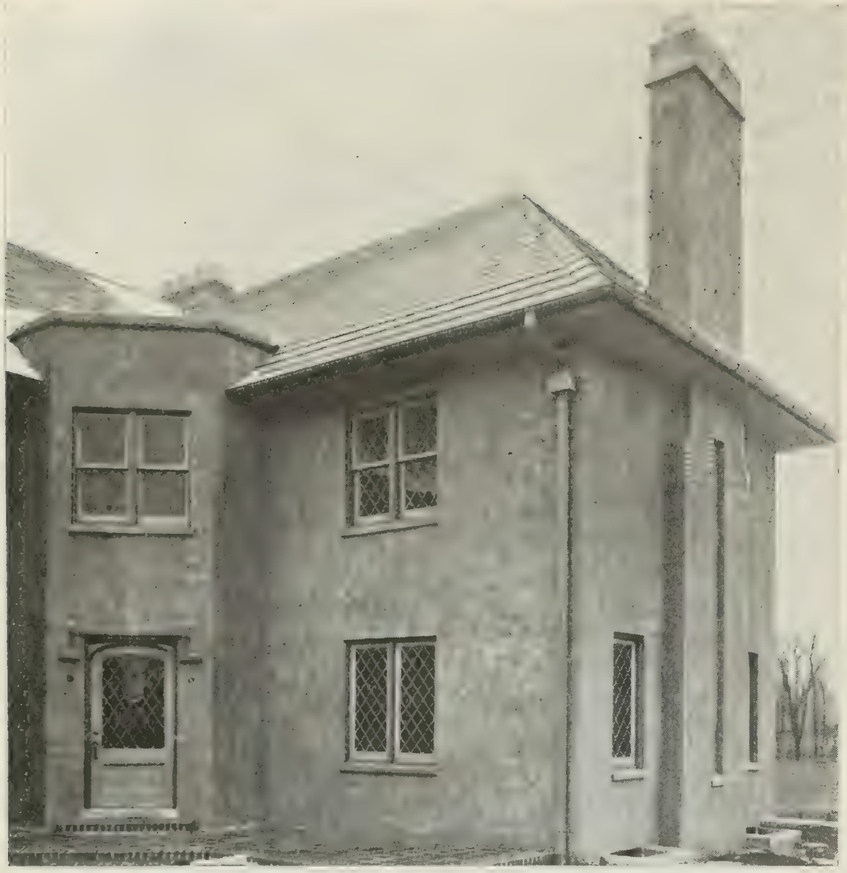

FIG. 6—HOUSE OF HOLLOW TILE WITH ROUGH CAST STUCCO PAINTED A ROSE PINK

The wood work is cypress painted green and the roof is covered with rose and green slates shaded from dark at the ridge to light at the eaves and graded in size and thickness

with gray and white cements. If pigments are used they should be mixed with the sand or gravel and then with the cement. A uniform mixture cannot be obtained if any of the ingredients are wet. Mixing in paste form is sure to distribute the color unevenly, and the trowel striking a lump of color will produce a spot or streak. By mixing the ingredients dry, a sufficient amount for the entire operation may be obtained and kept until needed, pure water being added to such quantities as may be immediately required. This method prevents the unsightly unevenness in color that generally occurs when batches are mixed at different times. Smooth surfaces that are floated or troweled rarely show a perfectly even color, no matter how accurately the ingredients are proportioned nor how carefully they are mixed. No two men use a float or trowel alike, nor can one man continually preserve an even degree of pressure; consequently different surface textures occur from the varying amounts of cement or fine material that come to the surface, due to uneven pressure, producing a difference in shade or color. Freezing will also change the color of stucco, as will sunlight, a dry wind, or cloudy and rainy weather. A moist, cloudy day is the best for a good stucco finish, and where it is exposed to the sun or wind the stucco should be covered with damp cloths hung to protect it, and invariably the whole of one unit of space should be completed in the same operation.

In a climate such as we have above the Mason and Dixon line the admixture of ordinary lime in stucco is not advisable. It cheapens the first coat and makes it flow more easily and in quicker time from the mason's trowel, and for these reasons is often used in place of an adequate proportion of cement. It is difficult to prepare and to mix thoroughly the lime paste with the cement and sand, and particles of unslacked lime are apt to enter the mixture, to its detriment. Hydrated lime (a lump lime slaked by a mechanical process, in which the water is driven off, leaving an impalpable powder) overcomes this objection, but as hydrated lime is practically as expensive as Portland cement, its use serves little purpose other than to lighten the color of the stucco and to "fatten" the mixture and so make it work more easily under the float.

Stucco should never be applied in freezing weather. If the water freezes before the cement has set, the stucco will not harden. Nor should stucco ever be disturbed before the cement has set, otherwise it will not adhere to the surface to which it is applied. While a frame building covered with stucco is in no sense fireproof, such a covering does act as a fire retardant. Stuccoing should always be started at the top of the building and the work carried downward to some projecting member or recess. If it is impossible to complete an entire wall at one operation, the work should be halted at some division line, such as a band, window or door. Three coats of stucco are desirable if the finish is to be smooth. For a rough-cast or pebble-dash finish, two coats will suffice, but the thickness of the stucco should not be less than 1″.

A smooth finish is secured by bringing the final coat to an even surface with a wood float; under no circumstances should a steel trowel be used for this purpose. Rough-cast and pebble-dash finishes are obtained by applying gravel or pebbles, mixed with cement, sand and water, dashed on with a paddle or a whisk-broom after wetting down the under surface. This gives a very pleasing texture and a variation in tones that overcomes the monotony of a perfectly smooth and uniform surface.

One of the most interesting and attractive of the various surface treatments employed by the writer is what is termed the "dry-dash." The first, or "scratch" coat, is applied in the usual manner and immediately followed by a second or "brown" coat. While still wet, aggregates of marble and stone, selected for their size and color, are dashed upon and partly embedded in the soft background. For this work the following specification is given — but it is coupled with a warning that the effect cannot be obtained by an unfamiliar and untrained hand:

> After thoroughly wetting the outside face of the tile, cover with a scratch coat composed of 3 parts sand to 1 part lime that has been blended for 3 wks., adding some hair and 1 bbl. cement to 1 bbl. of lime mortar. Follow up with a coat for dashing composed of 1 part sand, 1 part lime mortar and 1 part cement. While wet, dash with crushed stone in sufficient quantity to cover the walls. On outside frame walls covered with wire lath apply scratch coat as above and follow up with a brown coat of the same mixture but without the hair. Then apply coat for dashing as above and finish as above. Allow ...... dollars a ton for the crushed stone, to be of the size, kind and color selected by the architect.

The "personal equation" cuts a large figure in stucco work. Few men in this country have either the

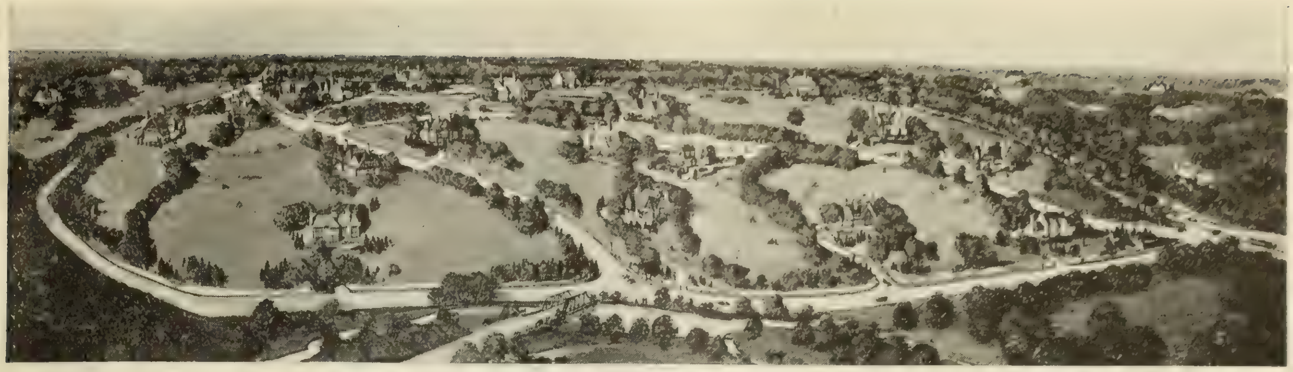

FIG. 7—SKETCH SHOWING GENERAL VIEW OF OGONTZ HILL, AS PROPOSED AND NOW PARTIALLY BUILT UP. OSWALD C. HERING AND DOUGLAS FITCH, ARCHITECTS

knowledge or the "knack" of applying stucco in a manner that will be both durable and pleasing in appearance. The obstinate adherence of the average workman to his own notions, and the opinion he entertains that the specification prescribed by the architect is of no great importance, operate strongly against one's best endeavor. The writer has made it a rule to impress upon his clients the importance of employing the most skillful men who appreciate the necessity of a strict observance of the precepts respecting the method and mixture required to produce the desired effect.

It should be borne in mind that stucco is subject to the action of the weather, including heat, cold, moisture and aridity, to shrinkage, settlement and all the ills to which the exterior walls of a building are heir.

The fine hair-cracks that frequently appear upon the finished surface of stucco, called crazing, are generally due to the too rapid evaporation of the water, before the cement has had time to set. These cracks may be largely avoided by stuccoing on a damp, cloudy day, when there is little or no wind, or by protecting the stucco from sunshine and wind by screens or other device. An occasional crack, if it is not too large or due to a structural defect, is not a serious blemish. In fact a flawless one-toned wall is apt to be painfully monotonous and must be partly covered with vines before it can lay claim to any beauty. Generally speaking, a completed stucco house looks its worst at the moment of completion.

The decorative possibilities of stucco are almost unlimited. It may be used as a unit covering, tinted in various colors; combined with "half-timbers," it provides a striking contrast to these wooden members in color and texture; and when used in connection with brick and stone an infinite variety of schemes is made possible, each material acting as a foil to the other. The "parge work" of England is an example of modeled stucco ornamentation that might readily be adapted to American needs, and Italian sgraffito could be used to advantage in relieving the monotony of a single-toned surface.

Stenciling with colored cement washes is an interesting way of treating a smooth stucco surface, but this method of decoration is more usually confined to porches, loggias and portions protected from the action of the weather, for the range of coloring matter in present use includes none of any great permanence when exposed to the elements. There has just been placed upon the market, however, a paint[3] apparently possessing unfading as well as waterproofing properties which has led the writer to use it in coloring the stuccoed walls of houses illustrated in this article. In one case the surface is white rough-cast and a rose-pink paint has been applied with a quick stroke of the brush to color the rough projections only, allowing the pockets between the pebbles to exhibit the natural color of the stucco. When Dame Nature takes a hand and films the surface with the gray tints of Time—a sparkling and mottled pink, white and gray effect will be obtained such as would not be possible in a one-tone mixture or with a thorough coat of paint.

It may be said of colored stucco that, owing to the lack of experience or courage, very few examples are to be seen in America that excite favorable mention. When the work is exposed to the weather the mistake is invariably made of selecting such shades and tones as are effective at the moment, forgetful that the ravages of Time, the action of the sun, wind and water conspire to bleach, and the dust to blacken, the chaste tones so fondly conceived. More daring is required of the architect and more confidence of the owner. Time should be discounted, even at the expense of a year's nervousness over a glaring chromatic display.

The reason which prompted the development of Ogontz Hill, illustrated in these pages, was not a desire on the part of the owner to make a quick and handsome profit and "pull out," but a belief that a suburban community begun and carried out along the lines laid down by a previously and intelligently designed plan, would be not only a more enjoyable place to live in than one in which none of the restrictions hereinafter described is required, but that the venture in the end would prove to be sufficiently profitable to establish a paying precedent for this method of developing suburban real estate. In domestic architecture the ultimate cost is not generally of such paramount importance as it is in commercial work, where the revenue from the investment is the principal cause of the building. Questions of sentiment and the indulgence of personal fancy often run up the cost of a private dwelling after the work has begun, a ruinous course where the project is a business venture pure and simple. In the development of a tract of land for domestic purposes the fact that the cost of the undertaking is of the first importance must not be lost sight of. In other words, the proposition is a commercial one, even though the product is for domestic use. To combine artistic excellence with honest and efficient workmanship, and place both upon a paying basis is, therefore, the problem that confronts the professional adviser of the men whose money he proposes to spend in planning for the future homes of the city's population.

While evidence abounds of more than a dawning appreciation of good urban architecture, and popular feeling akin to personal injury and shame is aroused over any new disfigurements of our cities and towns, the prostitution of the suburb and countryside continues. Properties originally laid out with no consideration for future growth and appearance, cut up into narrow building lots and sold to speculative builders who erected thereon houses through which the elements whistled a dismal dirge to the expectations of the trusting purchasers can be seen in the outlying districts of any of our large cities and they present a sad spectacle of Nature misunderstood and abused. Happily now and then is also seen the evidence of the guiding spirit of some individual, or company of men, of culture and foresight, endeavoring to reclaim these debauched settlements of the speculative builder or to inaugurate new developments upon a sound and worthy basis. A number of suburban tracts of land are now undergoing this wise and providential process of reclamation.

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[3] Valentine & Co., N. Y. C.

Such has been the course pursued at Ogontz Hill. In contrast to the "hit or miss" methods of the average real estate promotor, Ogontz Hill, constituting a tract of about 40 acres of rolling country near Philadelphia, was taken over in its virgin state and laid out according to a carefully prepared plan. It has been divided by main thoroughfares into three sections, and the largest section subdivided by a "lane." The main arteries are direct, convenient and of ample width and are carefully graded in correct relation to the topography. The "lane" is not needed as a thoroughfare and has been planned and constructed to discourage its use as such, to meet its purpose of a quiet, attractive residence street, narrow and winding, giving to it a cosy, self-contained, domestic character in the contrast to the more open and wind-swept thoroughfares devoted to traffic.

Each section is divided into plots varying in size from a quarter of an acre to an acre, the boundary lines being determined both by the topography and the attractiveness of the site. Believing that buildings of tasteful design, constructed of stone, concrete, hollow tile stuccoed, or other permanent materials, even at greater initial cost, are really more economical by reason of their durability and the lower cost of maintenance than the repulsive, poorly built structures so common in the outlying districts of our great cities, and believing also that good landscape plays an equally important part with good architecture in the practical and esthetic development of such a community, the owner engaged the services of men experienced in domestic architecture and landscape design to lay out and establish this attractive "residence park" as an inducement to people of moderate, as well as of more considerable, means, to give up the cliff-dwelling life in the "flat" and the dark and narrow confines of the usual city block house, and at no greater expense or sacrifice of time in traveling back and forth to acquire an individual home, exposed on four sides to the sunlight and air and situated in a healthful and attractive environment.

The topography of Ogontz Hill, the presence of sand deposits and ledges of stone within the confines of the property, together with a noticeable predilection on the part of the neighbors for English architecture, were factors which led the architects to select a free adaptation of the modern English style for the proposed houses. Five of these, costing from $12,000 to $20,000 are nearing completion. All have outside walls of stuccoed, hollow tile, in some cases combined with brick and stone, and all are roofed with slate and the chimneys crowned with "pots." Thus while all are of the same "family" each differs from the other and has its distinct character as has each member of the human family. A brief description of the exterior appearance of the houses will be found in the captions to the illustrations.

The impression held by many that beauty in form and color translated into architecture is measured by dollars and cents is false. The materials and labor employed in building houses of concrete, and of other units covered with stucco, are comparatively inexpensive in certain localities and in the hands of architects experienced in their use are mediums through which an architecture of great and lasting beauty may be obtained at less cost than when interpreted in brick or stone, and often at no greater cost than in wood.

The charm of personality portrayed in a human being is not measured by the contents of his pocketbook, nor are the taste and beauty displayed in the architecture of his country or suburban home dependent upon its cost.

Proximity to the railroad station and the shops need give no offense to those who would build their homes close by these conveniences. A village center may be made the most beautiful feature of the community if it is designed with that object in view and it may be done at no greater cost than were each individual allowed to erect his "store," without relation to its neighbors or the site.

Concrete and stucco houses are practical, ornamental and an asset in any community, particularly the unburnable kind, when designed by architects who understand how to use these materials in producing a sane, logical and beautiful architecture. The restrictions that control the building of houses at Ogontz Hill have been modeled on those which govern Roland Park, a residential park noted for its beauty and general excellence in the plan and structure of its streets and dwellings situated in Baltimore, Md. To country and suburban real estate promoters who claim that restrictions upon the kind and quality of the architecture is "impractical" and would prevent a ready sale of the land, the following extract from the printed restrictions of Roland Park should be of interest:

> A drawing showing the location of the house on the lot, the proposed finished grades, and the relative levels of the lot and street grades of the first floor, must be furnished before the Company can consider the working drawings for approval.
>
> In order to avoid, as far as possible, needless work and expense, the Company will consent to a tentative consideration of preliminary sketches. Such consideration is, however, distinctly tentative, and approval of plans can be based only upon the completed working drawings from which the house is to built.
>
> When the house is to be located on a corner lot, it should either have its principal entrance toward the street on which the lot normally fronts, or, if the entrance is to be on the side street, care must be taken that the house be so designed that it does not back up against the adjoining lot to the detriment of the latter.
>
> No residence or dwelling-house shall be erected costing less than ...... thousand dollars; the exterior exposed surfaces of the walls, with the exception of trims and moldings, shall be of brick, stone, concrete, stucco or other material of similar character, and if any building is erected, or any alterations made, such building or such alterations shall be made according to plans (including exterior color scheme, grading plan, and the location of such building) which shall have been approved by Roland Park Company.

Many stucco houses are being built to-day with walls improperly prepared and covered with stucco that lacks enduring qualities. Whether from ignorance or to save the first cost, the owners of these buildings will rue the hour in which they decided to employ cleap or ill-advised methods. It is a great misfortune that the average man builds but once; but all the more reason, then, that he should seek or listen to expert advise. Knowledge of any kind of building construction is generally limited to that acquired by frequent contact with building operations, and the layman should hesitate long before dictating how his house shall be constructed. A little knowledge is worse than none. While it is often difficult for the architect to prevail upon his client to spend a little more in good construction and to convince him that it will be a good investment and economical in the end, the day of stubborn opposition to such arguments is passing. We are beginning to build for posterity.

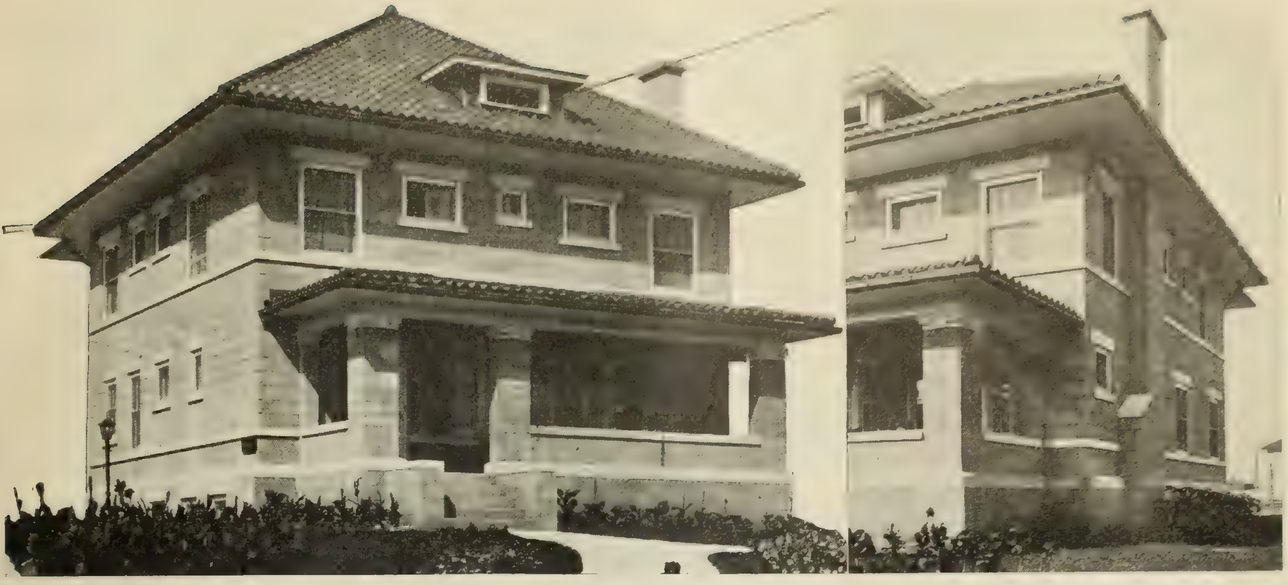

FIG. 1—TWO VIEWS OF RESIDENCE AT MOOSEHEART, ILL., BUILT OF FACED CONCRETE BLOCK AT A SAVING OVER FACED CLAY BRICK OF 19.7%

Concrete Block Used in Attractive and Economical House Construction at Mooseheart, Ill.

The accompanying floor plans and illustrations from photographs show the residence and office of the dean at Mooseheart, Ill., being one of the many buildings with walls of concrete block which are being constructed in a large group by the Loyal Order of Moose, as a philanthropic and educational institution.

The manufacture of these block and their use in construction work, with detailed costs, have been described in previous articles[1] by R. F. Havlik, who is in charge of the work.

Mr. Havlik supplies the present data and plans.

The building is 33′ x 33′ in plan with two stories and a basement, but in reality it is a three-story building without a basement. The entire interior of the building is plastered so that it consists of 12 finished rooms and a large bath room. There is a sleeping porch approximately 8′ x 28′, a large front porch of the same size, three sets of concrete steps leading to the rear and the front porch and to the Dean's office in the basement. The area-way leading to the office is faced with concrete on both the inside and the outside. The maid's room, the library and the office are trimmed with yellow pine and finished in natural color. The maid's room and the office are both floored with the best grade of clear oak, 7/8″ thick. All of the basement rooms are plastered with two coats of plaster, sand-finished. The inside stairway leading to the first floor is of oak. The reception room, living room and dining room are trimmed in oak, and the wood work is finished in old English. The walls of the dining room are paneled in oak. The kitchen is trimmed with yellow pine. The refrigerator is so placed that it can be filled from the outside.

All the porch floors are of concrete but the inside floors are of wood construction.

All the floors of the first floor, with

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[1] CONCRETE-CEMENT AGE, July, 1914, p. 16; Aug., 1914, p. 55

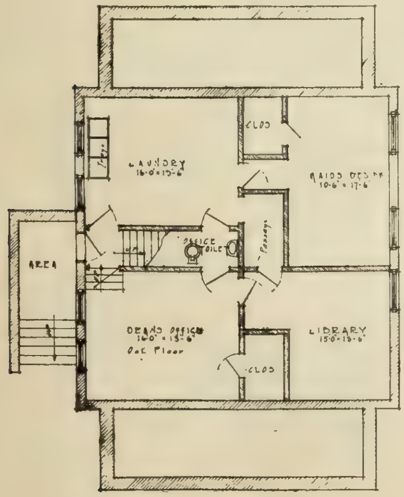

FIG. 2—BASEMENT PLAN

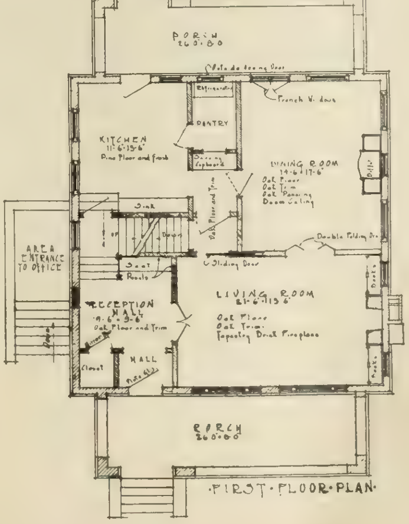

FIG. 3—FIRST FLOOR

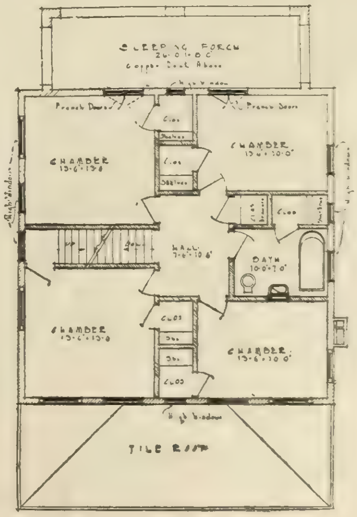

FIG. 4—SECOND FLOOR. SCALE 1/20″=1′

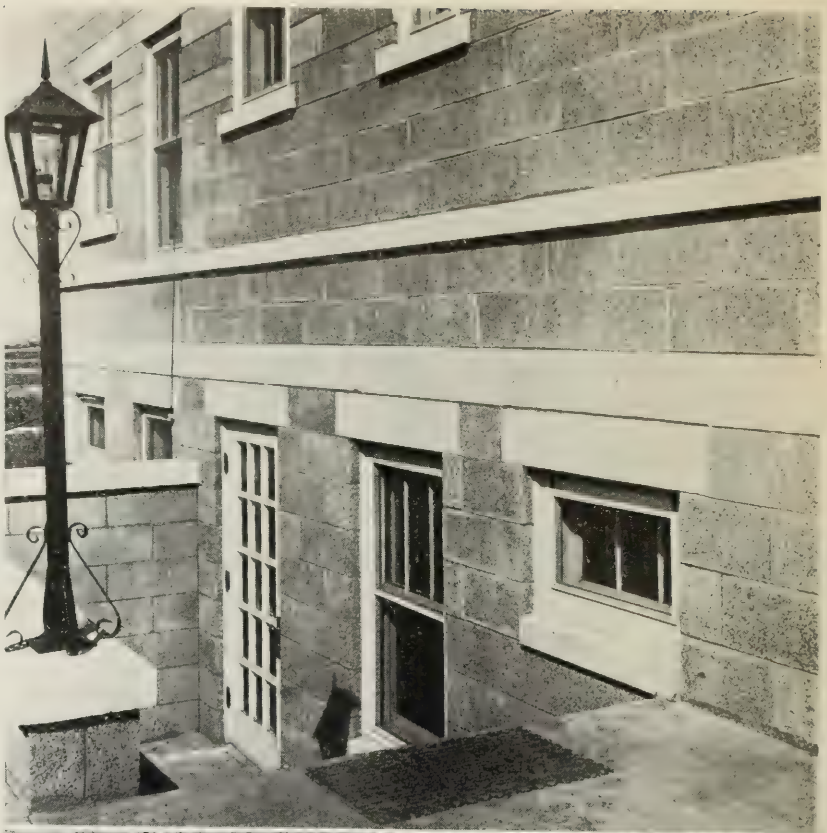

Fig. 6—Detail of Basement Entrance

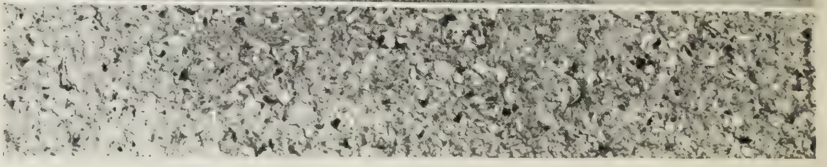

Fig. 7—Detail of Faced Block Surface

the exception of that in the kitchen, are of clear oak, 7/8″ thick. There is a large fire-place in the living room and elaborate bookcases are built in on both sides of the fireplace. The dining room has a finely finished oak buffet built especially to fit the room. French windows open from the dining room onto the rear porch.

The second floor contains four large chambers and a large bathroom. Each room is supplied with a large comfortable closet. The two rear bedrooms open directly on the sleeping porch. All of these rooms are trimmed with clear birch and stained a mahogany color, wax-finished. In building this house it was felt that it would be more or less of a public building, because the Dean would be required continually to entertain a large number of visitors, so it was considered advisable to build as pretty and comfortable a home as possible. Therefore no expense was spared in this building to attain this end. For this reason total costs are of little consequence in a consideration of the economy of concrete.

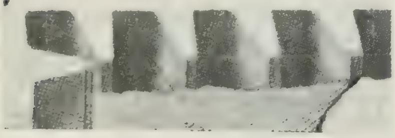

Fig. 5—Wall Construction With Two-Lug Block

The roof of the sleeping porch is covered with 16-oz. copper. The front porch and the roof of the main building are covered with Spanish red tile. Future residences of Mooseheart will not be so elaborate internally as this one, as a residence of this size is far too large for the ordinary family, but this is an excellent example of the character of work that can be done with the Mooseheart concrete block and trim stone. In general this building represents the type of building that will be put up at Mooseheart for residential purposes. All of the block used in this building were made by the Hydro-Stone[2] process, faced with Mica Spar Crystals.[3] Universal Portland cement[4] is used for all the granite block and for the backing of the trim stone. Some of the trim stone used at Mooseheart has been faced with Medusa white cement[5] and some has been faced with Atlas white cement[6] both of which have proven satisfactory.

From Mr. Havlik's previous accounts of concrete block construction the costs of the wall construction are taken.

The block used in the Dean's home are of the two-lug type, giving a wall with a minimum thickness of about 2½″ and two projecting lugs on which furring strips are attached vertically by means of wall plugs or wire loops, held in the joints. The interior lath and plaster are then applied on the furring, giving a light yet stable and well insulated wall. All block used above ground on this house are faced, and washed and scrubbed while green to expose and brighten the facing aggregate.

The cost of material for block of this kind, using a 1:5 backing and a 1:2½ facing (face area of block 9″ x 24″; thickness including lugs, 8″) has been 9 cts.; the cost of labor in manufacture, including delivery, 7 cts., and overhead at 20%, 1.8 cts. This gives a total cost of 17.8 cts. per block, each block filling an area of 1½ sq. ft. in wall surface. On this basis 100 block giving a wall area of 150 sq. ft. cost $17.80, allowing for no manufacturing profit. Or allowing a manufacturing profit of 25% the cost of material for 150 sq. ft. of wall becomes $22.25. The cost of laying has been 11 cts. per block, or on 100 block $11.00, giving a total cost for 150 sq. ft. of wall of $33.25.

The cost of 150 sq. ft. of 8-in. brick wall, the thinnest brick wall generally permissible, would include these items: 900 brick laid at $16.00 per M, $14.40; 900 face brick laid at $30.00 per M, $27.00; a total of $41.40. The saving in using the granite block is thus $8.15 or 19.6% on the cost of brick.

Piles of the "cast-in-place" type, made by forming a hole in the ground and filling it with concrete, may be either plain or reinforced, depending largely upon the character of the work for which they are to be used. They are usually without reinforcement.

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[2] Barron and Harridge, Chicago

[3] Crown Point Spar Co., N.Y.C.

[4] Universal Portland Cement Co., Chicago

[5] Sandusky Portland Cement Co., Sandusky, Ohio

[6] Atlas Portland Cement Co., N.Y.C.

Some "Worked Out" Details in Concrete House Construction

By A. Morgan Smith[1]

Present-day building materials and modern requirements make the residence more substantial, and materials that are liable to rot or rust are largely eliminated.

Beginning with cellar wall, cellar floor, porch floors and steps, concrete has made possible the first advance toward permanent residence construction; even today all houses of any consequence include these features in concrete and the same conditions and circumstances that favor this good start are just as favorable toward completing the residence with concrete. Just as soon as the builder becomes more familiar with the use of concrete in residence construction the concrete house will be an everyday proposition and entirely practicable for the man wanting permanence, the lowest up-keep cost and nothing to fear from fire.

Conventional ways of building with other materials, such as an 18-in. cellar stone wall, increased wall full height for chimney bearings and 13-in. walls for first story, handicap the use of concrete,—but when it is clearly understood that a concrete wall will distribute and withstand different stresses more safely than a wall of stone or brick of the same thickness, it is apparent that material can be saved by using a thinner wall of concrete.

For the average two-story house with 7-ft. cellar a 10-in. cellar wall and 8″ for the first and the second story wall is heavy enough. Reinforcing steel should never be omitted; with the slight extra cost, the fear of cracks is overcome.

Two ⅝-in. bars should run continuously in all walls and partitions just over window and door heads. Local conditions better determine the quantity and placing of vertical steel.

Inside partitions should be about 4″ or 5″ thick. Grounds for base rails, etc., with grooves for wiring and piping, must not be overlooked. Small holes for pipes are easily provided by wrapping a few layers of heavy paper around a stick and placing where the hole is wanted. The paper makes removal an easy matter.

Forms for the cellar wall and the first-floor slab should be built at the same time so that the wall and the slab may be poured integral and likewise the walls and slabs for the first and the second story.

The outside walls should have air space provided with ⅞-in. x 2-in. furring strips; the air space is recommended where zero weather is expected as the saving in heating fuel will pay for the air space and the house will be cooler in summer.

The thickness of the floor slab and amount of reinforcing required will vary according to the span and should be carefully worked out both in design and construction.

Tile or terrazzo floor may be laid on the floor slab at much less cost than over wood joists. Wood floors may be laid over the slab on wood sleepers in the usual manner.

The concrete roof is an important part, as is also for appearance the top part of the house, whether it is called the cornice or the parapet. Where the roof is flat, a combination roof and cornice works out well and is simple in construction. Fig. 1 shows one arrangement; the appearance here is extremely plain but it may be built to suit individual tastes or style of architecture.

The roof bears entirely on the cinder fill, allowing freedom for shifting due to change in temperature. Care must be taken in cementing in the brass flange and pipe and the pipe must clear the hole in the slab

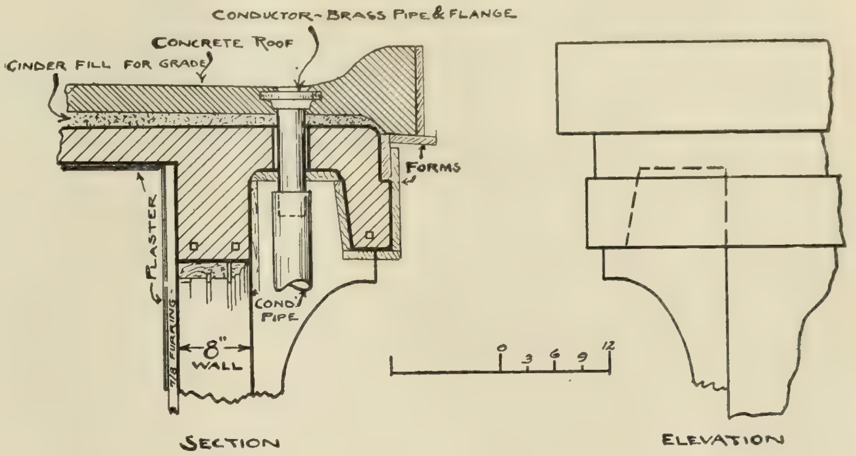

Fig. 1—Suggestion for Combination Roof and Cornice

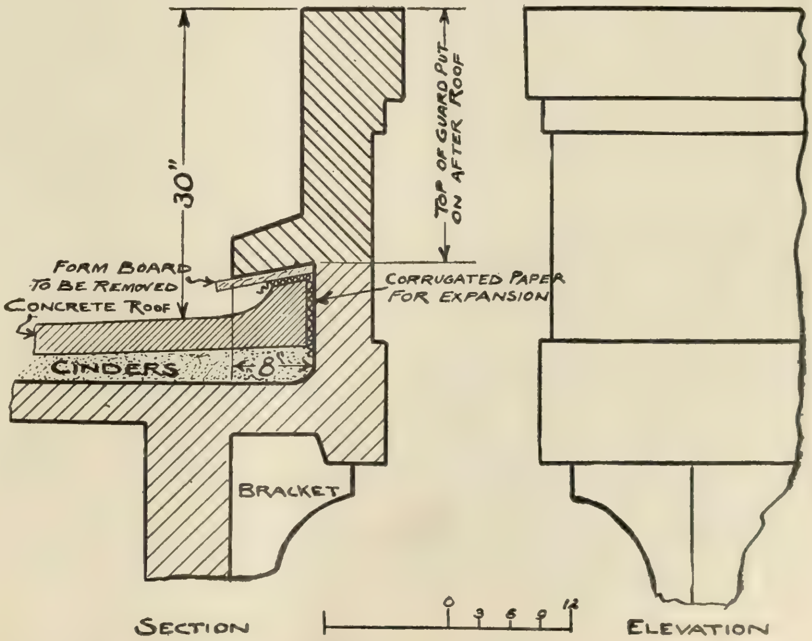

Fig. 2—Detail for Roof With Parapet or Guard

by at least ½″; a cheaper conductor may extend to the ground. Brackets may be placed at the corners and at intervals for support and appearance. The forms about this detail work should be well oiled to keep them from warping, which often causes cracks before the concrete is hard.

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[1] Architect, Mt. Lebanon, Pa.

Fig. 2 shows an arrangement of roof with parapet or guard wall. This wall is a means of safety where the roof space is utilized and when formed out on top is very suitable for growing plants or vines. About two layers of corrugated paper serve well the purpose here intended. It is collapsible under the roof expansion and the horizontal part makes easy the removal of the form board over it. My experience in roof construction has shown that Figs. 1 and 2 are very simple to build, are efficient and the work looks neat.

Cinders being light and not too dense when rolled to grade make a good inexpensive base for a concrete roof.

The roof should have a fall of not less than ⅛″ in 12″ and preferably about ¼″ in 12″.

The outside finish for a concrete house whether it be a plastered coat of sand-finish, rough-cast or pebble-dash will surely be a permanent job. The sand or float finish should be given last consideration.

Forms should be so constructed as to be readily accessible for inspection at all places and at all times and to be easily cleaned.

Care must be taken to see that the concrete and the wet forms are not allowed to dry out when salamanders or other artificial heaters are used to keep the work warm.

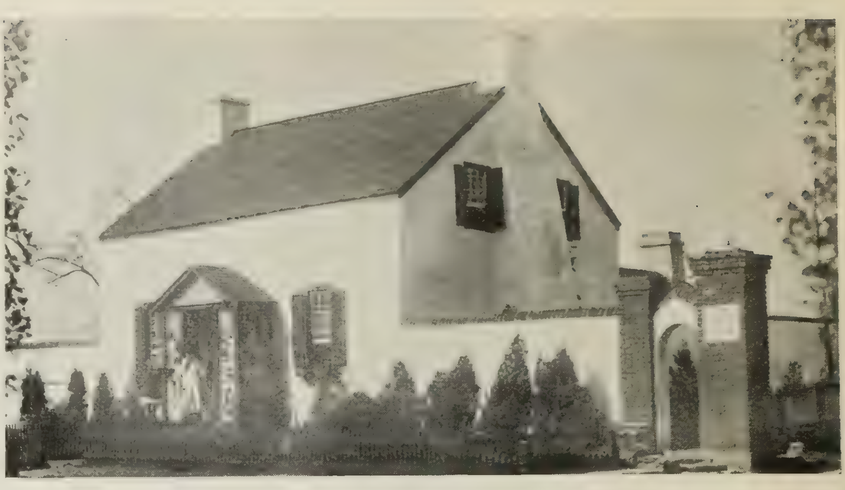

Fig. 1—Cottage With 12-in. Concrete Walls Built for $2,450. See Plans in Fig. 2

Two Cottages With Solid Concrete Walls, Built Near Middleburg, Va.

The two houses shown in the accompanying illustrations from photographs and floor plans were built by Claude H. Haga on the estate of Joseph B. Thomas, near Middleburg. Va. They are but two small units in very extensive concrete work, the stucco surfaces on which are made the subject of a special contributed article elsewhere in this issue.

These houses were referred to briefly in a previous article[1] by Mr. Haga describing work on the Thomas estate but the plans are unusually interesting and with them it is possible now to present more detailed data.

The houses are at the entrance of the Thomas estate, one for a lodge and the other for the residence of the gatekeeper. The front walls of both houses are continued in the walls of the estate. The house with a chimney at either end and with a lattice-screened doorway was designed by Mr. Haga, the other by Frederick J. Herner, N. Y. C.

The house designed by Mr. Haga has 12-in. walls poured in steel forms—the Morrill[2] system, using shallow pan sections 2′ x 2′. The dimensions are shown on the accompanying plans. The first story has a ceiling height of 8′ 6″, and the second story is 4′ to the rafter plate. Walls and chimneys contain approximately 95 cu. yds. of concrete. The mixture used was 1 part cement to 4 parts sand, poured wet and then filled in with field stones—all that the wet mortar would cover as the work progressed. Mr. Haga is of the opinion that 50% of the bulk of the wall is made up of fieldstones. The only reinforcing used consisted of bars placed around openings and in the fireplaces and chimneys. Chimney flues are of terra cotta and the steel forms were used in part in building up the chimneys, the taper being given by a wedge-shaped wood form section, moved upward as the work progressed. The fireplace was made with wood forms on which a steel throat rested. On this throat the flue lining was started. The fireplace was later lined with fire-brick.

Ground floor joists have their bearing on a ledge of the foundation walls which are 16″ thick except in the cellar section. The ceiling joists are

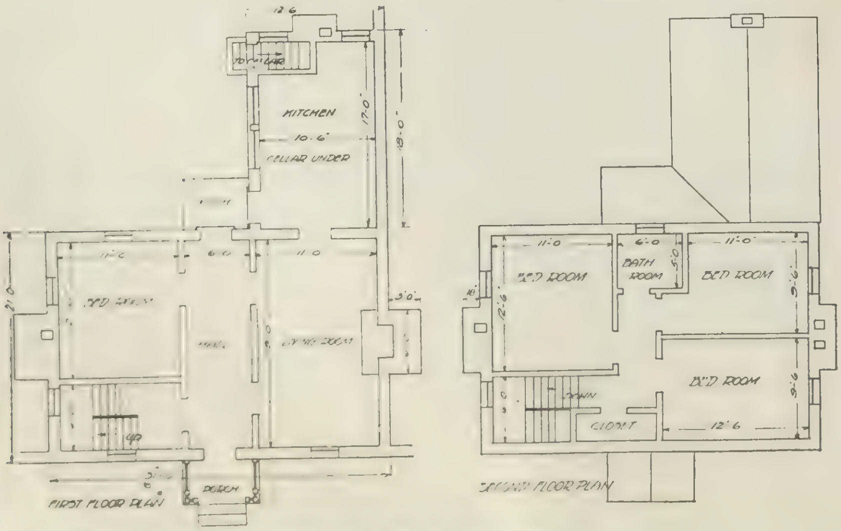

Fig. 2—Plans of Concrete Cottate Near Middleburg, Va.

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[1] Concrete-Cement Age, Jan. 1914, p. 6

[2] Milton Dana Morrill, Archt., Washington, D. C.

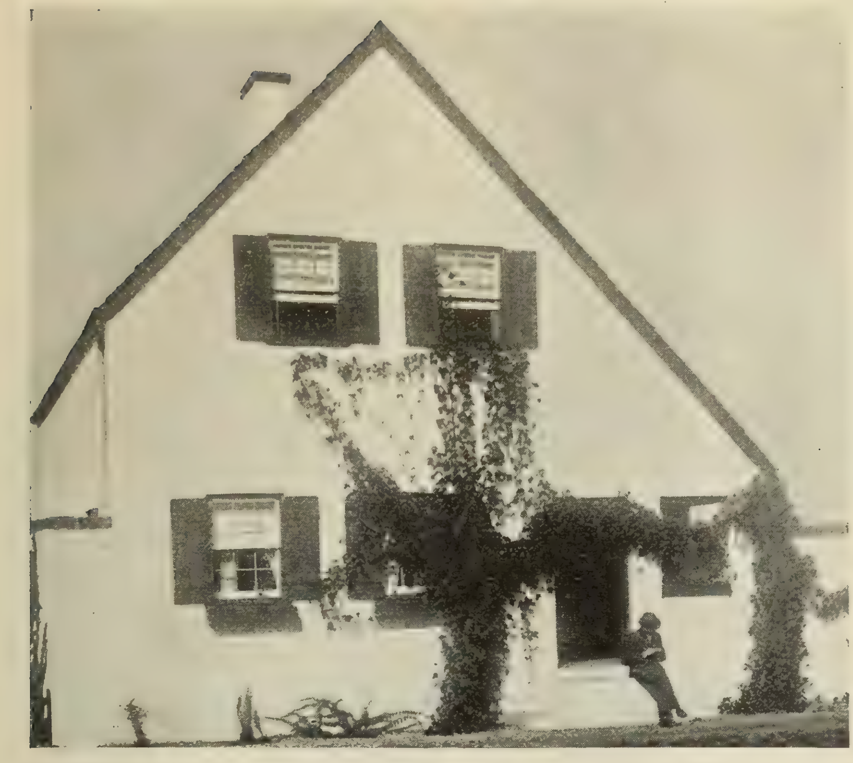

FIG. 3—CONCRETE COTTAGE WITH 8-IN. WALLS BUILT AT A COST OF $2,700. SEE PLANS IN FIG. 4

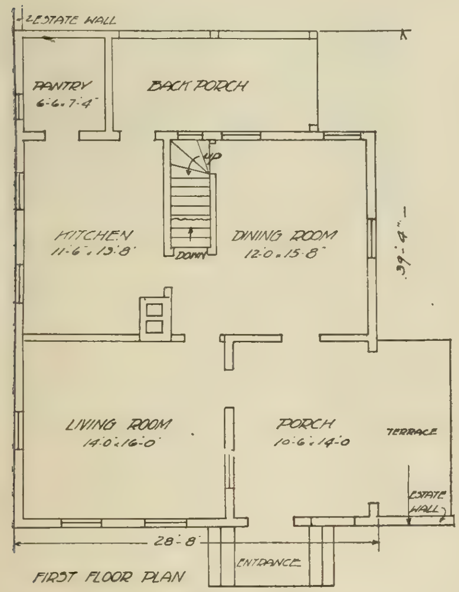

FIG. 4—PLANS OF $2,700-COTTAGE WITH 8-IN. WALLS NEAR MIDDLEBURG, VA.

fastened by joist hangers, held in turn by a 2-in. by 8-in. timber which is bolted to the walls. Mixing and placing the concrete were done by hand, but in placing the field stones they were dropped into the forms direct from wagons which brought them in, until the wall was above a height of 8′.

Mr. Haga figures form setting and removing on this house at $60.

The house is plastered direct on the concrete inside and stuccoed outside (description of stucco work elsewhere in this issue).

The other house has 8-in. walls of 1:2:4 mix, cement, sand and stone, and because of the thinner walls is much more strongly reinforced. It was also poured in steel forms. Both houses were built at about the same time and in connection with estate walls and various small outbuildings, Mr. Haga figures the cost of the 12-in. wall house at $2,450 and that of the 8-in. wall house at $2,700. He was sure enough of these figures to take a contract to build another house almost identical with the one with 12-in. walls and two chimneys at a price complete of $2,850, and expects to make a good profit. Other cottages being erected on the Thomas estate are also constructed with 12-in. walls using field stones for filler.

Preserving and Reinforcing Decayed Wooden Poles With Concrete

To prevent the further decay of wooden poles at the ground line, the East St. Louis & Suburban Ry. has constructed a special mixing plant to allow the easy transportation of concrete from the mixer car to the base of poles on either side of the right-of-way, according to *Railway Engineering and Maintenance of Way* for Sept., 1914.

The mixer[1] is mounted on one end of a 40-ft. double-truck flat car with a motorman's cab at the other end. Directly behind the cab is a 200-gal. cylindrical tank, the water being forced to the mixer through a small pipe by air under 10 lbs. pressure. The materials for a day's work are carried on the car between cab and mixer. The mixer is charged by means of a loading skip.

The mixer, set up as high as clearances would permit, is operated by an electric motor and under ordinary conditions has a capacity of 6 cu. ft. per min. The concrete is discharged from the mixer into an open gravity chute 10″ x 10″ with a fall of 8′ in its length of 18′. This chute is pivoted at the mixer and supported near the other end by a guy which permits swinging of the chute and raising and lowering it as the conditions require. This outfit has reduced the cost of concreting pole butts to about one-half of the cost of doing the work by hand.

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[1] A No. 0 special mixer made by the Marsh-Capron Mfg. Co., 477 Old Colony Bldg., Chicago

CONCRETE URN MADE AT SCHOOL OF INDUSTRIAL ART, PHILADELPHIA

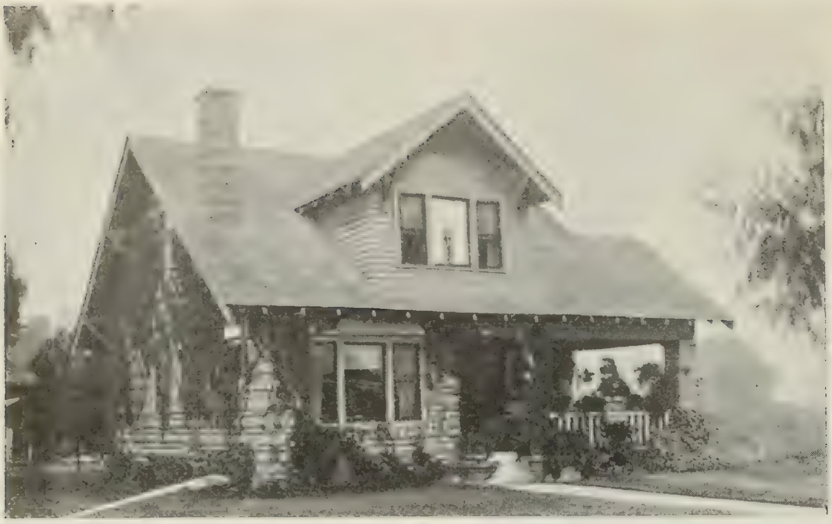

Fig. 1—Concrete Block Cottage, Riverside, Cal., After Two Yrs. in Which to Grow Into the Landscape

An Engineer's Concrete Block Cottage—Built in Riverside, Cal., for $3,000

By Rolf R. Newman[1]

Why should an engineer build a concrete cottage—particularly a concrete block cottage? Answer: (1) The block feature, including the alternation of wide and narrow courses, was especially desired by the friend for whom the house was constructed. (2) It was believed (and proved true) that a house of this "story-and-a-half" type, either in concrete or in concrete block, would involve interesting "how-to-do-it" features worthy of working out. (3) I believe, with Benjamin A. Howes, that "building contractors on the professional plane" can be of assistance in any and all parts of the building world of today.

The effort was made to see what could be done in an isolated house of this type for about $2,500, but on account of the later addition of a Solar heater and certain other betterments, the actual cost was slightly over $3,000—an exact segregation of the principal items being as follows:

Carpenter work—labor and material for rough and finish	$1,354
Concrete work—block, lintels, porch floors, steps, etc.	908
Plumbing	325
Plastering—inside, two coats direct on block	200
Painting	97
Electric work—wiring, fixtures and gas in kitchen	70
Hardware—rough and finish	60
Total	$3,014

The distribution of cost to the owner on a five-payment basis was worked out as follows: (1) ⅕ When block walls are finished to height of second story. (2) ⅕ When roof is on. (3) ⅕ When plastering is completed. (4) ⅕ When house is entirely completed. (5) ⅕ Legal period to free all liens (in California, 31 das.)

The house was built for R. J. Nelson, Riverside, Cal., but before completion he sold it to A. H. White, the present owner and occupant. Mr. White is an experienced California orchardist and has himself planted and tended the vines and plants that have so completely covered the cottage in two years' time. Four mos. was the time required to build the house and it was finished in the summer of 1912.

The first step was the manufacture of the block at the site of the house on a standard 8-in. x 8-in. x 16-in. Ideal[2] block machine. The crew on this work was two men and they made a maximum of 80 block in an 8-hr. da. While this work was in progress the excavation for cellar was made and solid concrete cellar walls, foundation walls and fireplace foundation were placed. The cellar hatchway and steps are also of solid concrete. The earth excavation for cellar and hatchway was trimmed vertically to a sufficiently true line to use it for the rear form, a wooden panel being used as the inside form and concrete being poured between the wooden form and the earth wall at the rear. This is a saving in form work which it is always good to try for if the ground in which work is being done will stand up.

All the sills and lintels were cast at the site. The lintels were cast separately in the same form, which consisted of a bottom and two side pieces of surfaced 2-in. plank long enough to cast the longest lintel (9′ 8″) with movable wooden end gates which were set in the form at any distance apart required to cast a lintel of a certain length. The face of the lintel to be exposed was cast down against the bottom of the form and all were reinforced. Not one was broken in raising them into place by hand power, but to avoid unnecessary handling of the longest one, which weighed approximately 800 lbs., it was cast on a platform on a level with and just opposite its location in the wall and when hardened it was rolled over into place The lintels, as well as the block, were given a ½-in. facing of 1 part cement to 2½ parts of sand, the backing being a regular 1:2½:4½ concrete—the coarsest particles of rock being not over ¾″ in diameter.

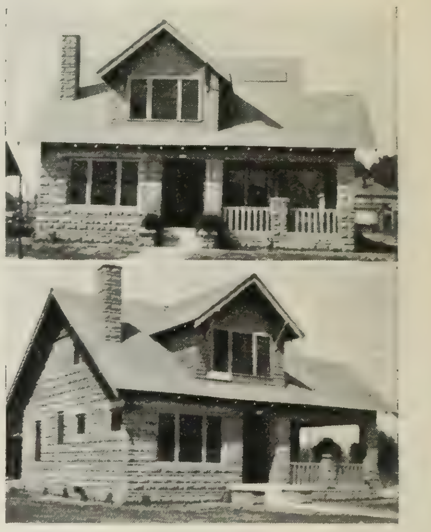

Fig. 2—Two Views of Cottage Soon After Construction

These, as compared with Fig. 1, show the value of vines and plants in architecture

The concrete block in the gable ends were carried up only to the top of the second story windows—the peak of the gable being finished in wood in connection with the wooden roof. Rafter plates of 2-in. x 6-in. rough pine were bolted to the tops of the front and the rear walls; to these the wooden rafters were nailed. The first and the second story floor joists fitted into notches in the block of the exterior walls and had a 4-in. bearing surface on these walls so that in every way the concrete and the

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[1] Civ. engr., Riverside, Cal.

[2] Ideal Concrete Machy. Co., Cincinnati, Ohio

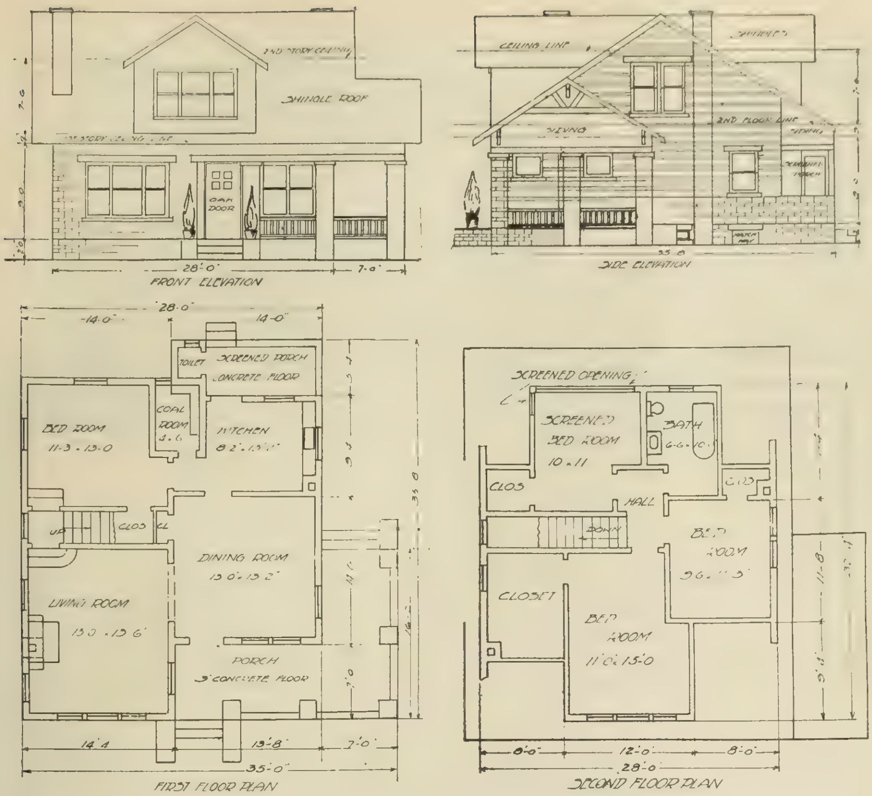

Fig. 3—Floor Plans and Elevations, Concrete Block Cottage

wooden portions of the building were tied together as firmly as possible. The only interior walls of concrete block are those of the cool room, which insulate this room from the kitchen and other portions of the house. This re-entrant feature at the center of the rear wall, together with the buttress effect of a chimney built into either side wall, and the column and wall arrangement at the front, gives the house wonderful stability and compactness. When it is considered that the net ground area covered is 28′ x 36′ or approximately 1,000 sq. ft., it will be recognized as quite worth while that so substantial and approximately "fire-safe" a house can be built for as low as $3.00 per sq. ft. of ground area.

It must be further recognized that the "story-and-a-half" type of house embodies many advantageous feaaures of appearance and of economy for the following reasons: (1) The relation of wall area to roof area is such that good proportions are easily maintained, even by those not greatly versed in architecture. (2) The amount and location of the concrete in the exterior walls of this type of house are such as to derive a maximum benefit without incurring the undue expense of raising it as high as even a full two-story house would require. (3) The arrangement of rooms with some below and some above has a recognized economy over any arrangement of the same number and size of rooms, all on one floor.

As to the contractor's plant (aside from the carpenter's tools furnished by my foreman and men working under him) necessary to build this house, $200 would cover it, including block machine, wheelbarrows, shovels, rope, etc. To build the same house all in reinforced concrete, using wooden forms, would require an investment in "plant" of at least $400; and the best figures I have on steel forms would indicate a minimum investment in "plant" using steel forms of $1,000. The "plant," to be sure, is in all cases available for the next job but we see in these figures a reason why, in the absence of a greater public demand for reinforced concrete, block have remained a "stand-by" of the small builder.

My complete "crew" on this job consisted of a foreman, familiar with both carpentry and concrete work, and five men (including the two previously mentioned as making the block). The foreman received $3.75 per da. of eight hrs. A regular carpenter with him received $3.50. Two carpenter helpers received $2.50 each. The man at the block machine (who also later laid the block) received $3.00 per da. and his helper received $2.00 per da.

Cement Market in Dominican Republic

Cement is being employed in increasing quantities in the Puerto Plata district, largely on account of the popularity of reinforced concrete construction, according to the *Daily Consular and Trade Reports* for Dec. 21, 1914. Nearly all new business buildings and a number of residences are of this type. The building trades have been active until the last few months, when most of the work has been suspended.

Cement is used in considerable quantities by the various town councils (ayuntamientos) for gutters, paving, etc.; by the two railroads and the Pub. Wks. Dept. for culverts and similar purposes; and by some of the largest cacao and coffee plantations for building drying floors.

Estimates of the total assumption of cement for the Republic are placed at 70,000 bbls. for 1913 and 40,000 bbls. in 1914. The estimated decrease for the current year is in line with the general business conditions that have prevailed. Probably one-third of the total is consumed in this consular district, which includes the northern Provinces known as the Cibao.

Probably 98% of the cement supply is of American origin, although there have been occasional shipments from Germany. It is specially gratifying to note that the good qualities of the American product, proximity to American ports and effective trade methods have won the market.

The cement is imported in the standard American barrel, weighing 400 lbs.

As is the case with almost all manufactured articles, cement has attained a high price when it finally reaches the Dominican consumer. The following figures show the cost per bbl. of imports in the usual size lots: Price per bbl., f. a. s. (free along side), $1.46; freight, New York to Puerto Plata, $0.63; commission, $0.07; consular fees, $0.05; wharfage, $0.18; lighterage, $0.07; duty, $0.18; total landed cost, $2.64.

The usual retail price in Puerta Plata is between $5.00 and $6.00 per bbl., although at times a higher price is quoted. In Santiago, the chief town of this district, the present retail price is $6.00 per bbl., in spite of the freight rate of $5.00 per ton from Puerto Plata, a distance of 42 miles.

The future expansion of trade in cement will probably depend more on the internal condition of the country than anything else. With tranquility and prosperity there should be a considerable increase. At present one American firm, which has actively cultivated the export field, supplies practically the entire demand.

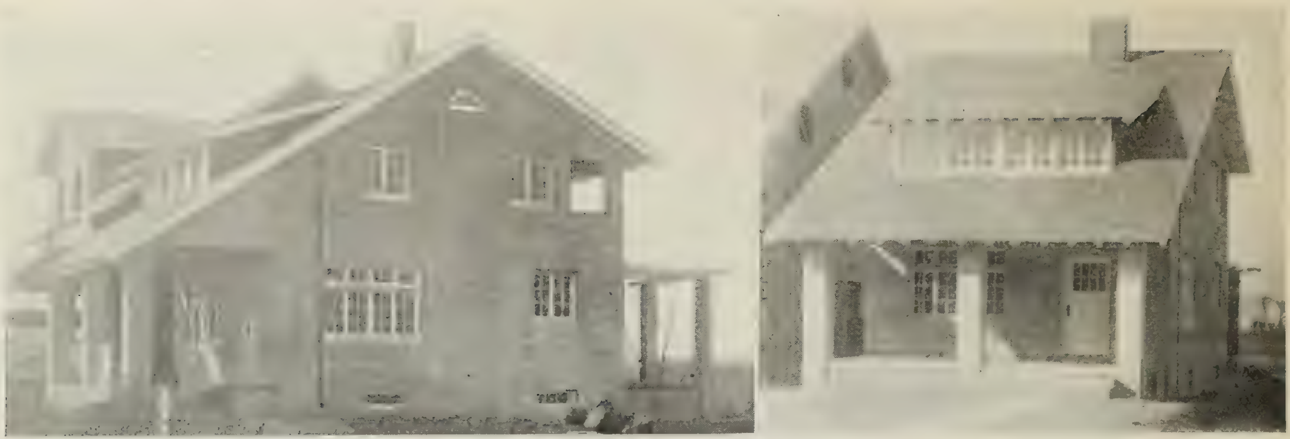

Fig. 1—Front and Side Views of Albany House Built of Concrete by New Method

House with Concrete Walls and Permanent Interior "Form" of Hollow Tile

By C. R. Knapp[1]

In building concrete houses where hollow walls are used it has been the general practice to use a movable core system, the core being moved up as fast as the concrete gets to the top of the core. I have used this method on a number of buildings but gave it up to use a 3-in. partition tile placed in the center of the wall making two 4-in. concrete walls with this 3-in. tile between. This way of producing a hollow wall has a great many advantages over the "pull-a-core" system besides showing a decrease in the cost. The saving of time more than overbalances the cost of the tile.

In building the concrete house here illustrated, I believe that I have made a still further advance in the hollow wall methods. The results fully bears me out in this belief. In this case instead of placing my hollow partition tile in the center of the wall I have used it for my inside form. This brings my two 4-in. concrete walls together, making an 8-in. solid wall and saving one line of steel reinforcement. The tile are held in place by a board or strip in front of the 2 x 4 uprights which are put in at regular spacing to match the 2 x 4's of the front forms. Reference to the drawing will show that the boards or strips that hold the tile in place come only at the points where the tile open. There is in this method a great saving because it saves building the inside forms and leaves only one side of the concrete wall to look after. The tile are more easily handled and can be kept in place better than when

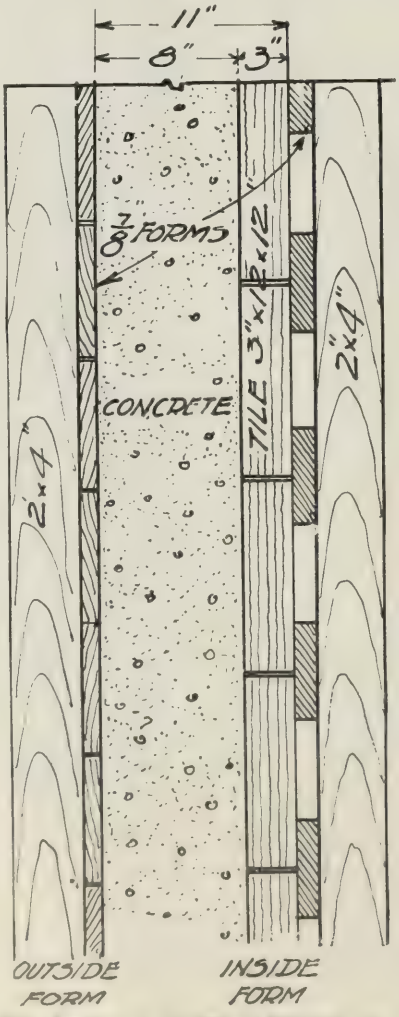

Fig. 2—Detail Showing Method of Wall Construction

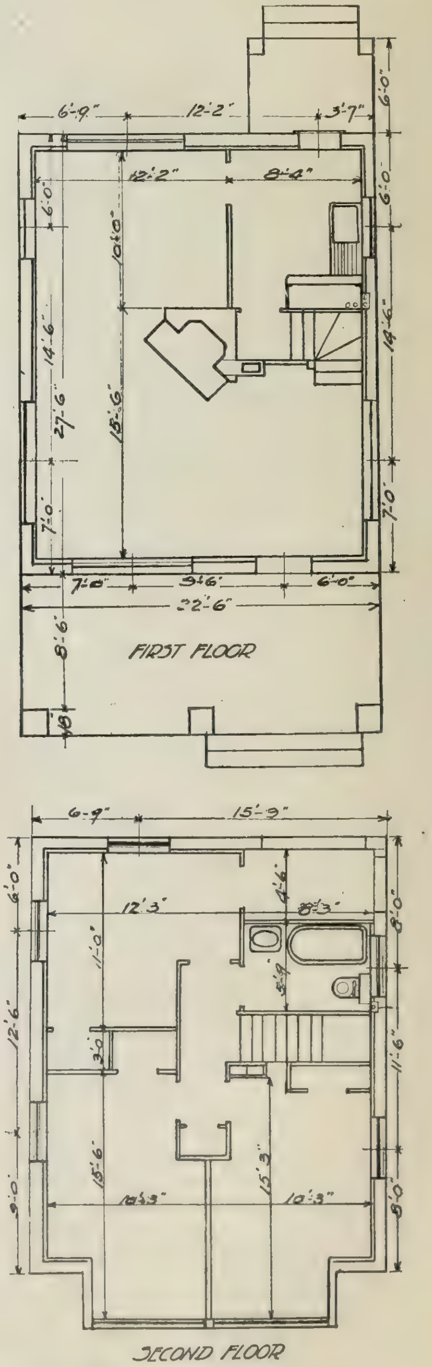

Fig. 3 Floor Plans

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[1] Builder, Albany, N. Y.

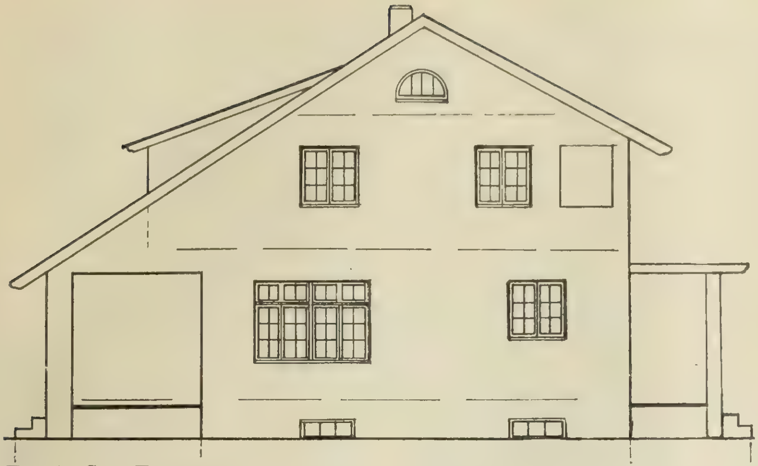


FIG. 4—SIDE ELEVATION

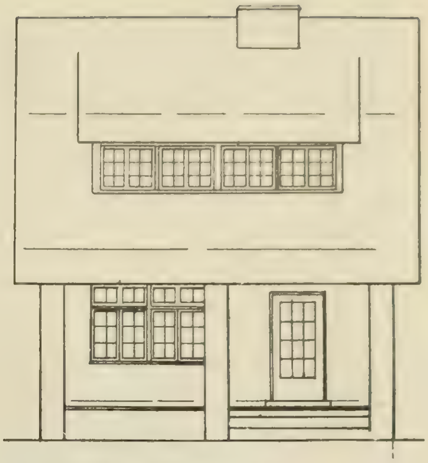


FIG. 5—FRONT ELEVATION

used in the center of the wall, and the air space is just as effective. In the finish of the inside wall the wall plaster is put directly on the tile, to which it adheres firmly.

The illustrations from photographs and the plans show the house built in Albany by the method described. It was built with idea of producing just a simple, cozy, homelike bungalow. It is a house built around a big fireplace. The openness or oneness of the lower floor, with no partitions except around the kitchen, is a special feature. Its large window spaces give plenty of good sunlight and these with the outdoor sleeping porch on the second floor rear show the owner's appreciation not only of light but of fresh air. The windows, all casements of a new style, are hinged in the middle and push out, the ends coming together.

The coal bin is under the front porch, sloping to a hole in the foundation wall near the heater, thus leaving no chance for coal dust in house. Cupboards for storage are built in foundation wall by using insets when concrete goes in. There is a beamed ceiling on first floor.

The finish of the outer wall is bush-hammered at a cost of approximatory 3 cts. per sq. ft. The roof is of red asbestos shingles, thus giving a touch of color.

The finish of the woodwork inside is mission. The finish of the woodwork outside is painted white.

Excess of water is detrimental to concrete, as it brings a layer of cement which has already set to the surface, forming a point of weakness in the finished work, unless it is well scraped off before the next layer is deposited.

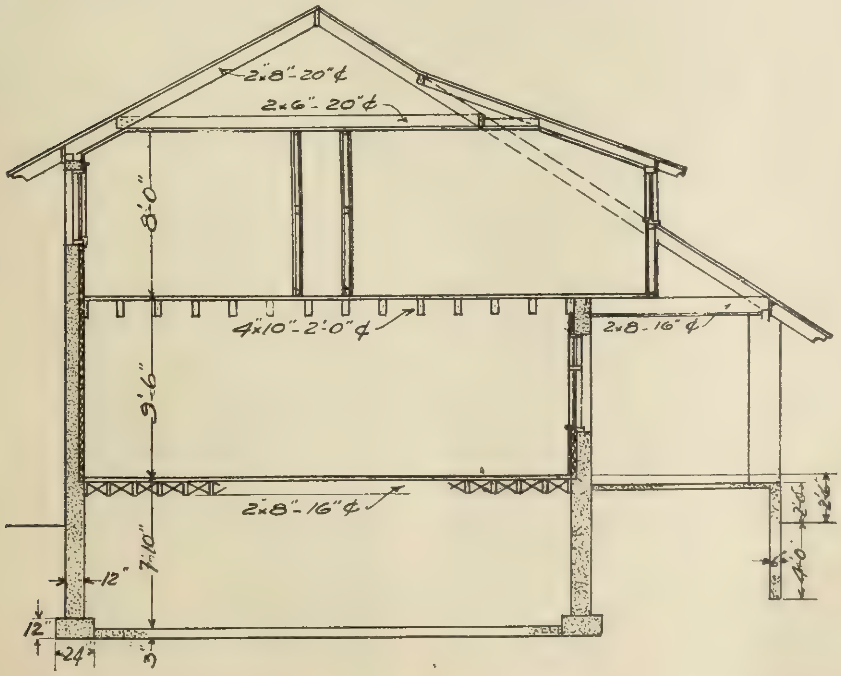


FIG. 6—SECTION

Cement Second in Pennsylvania's Mineral Industries

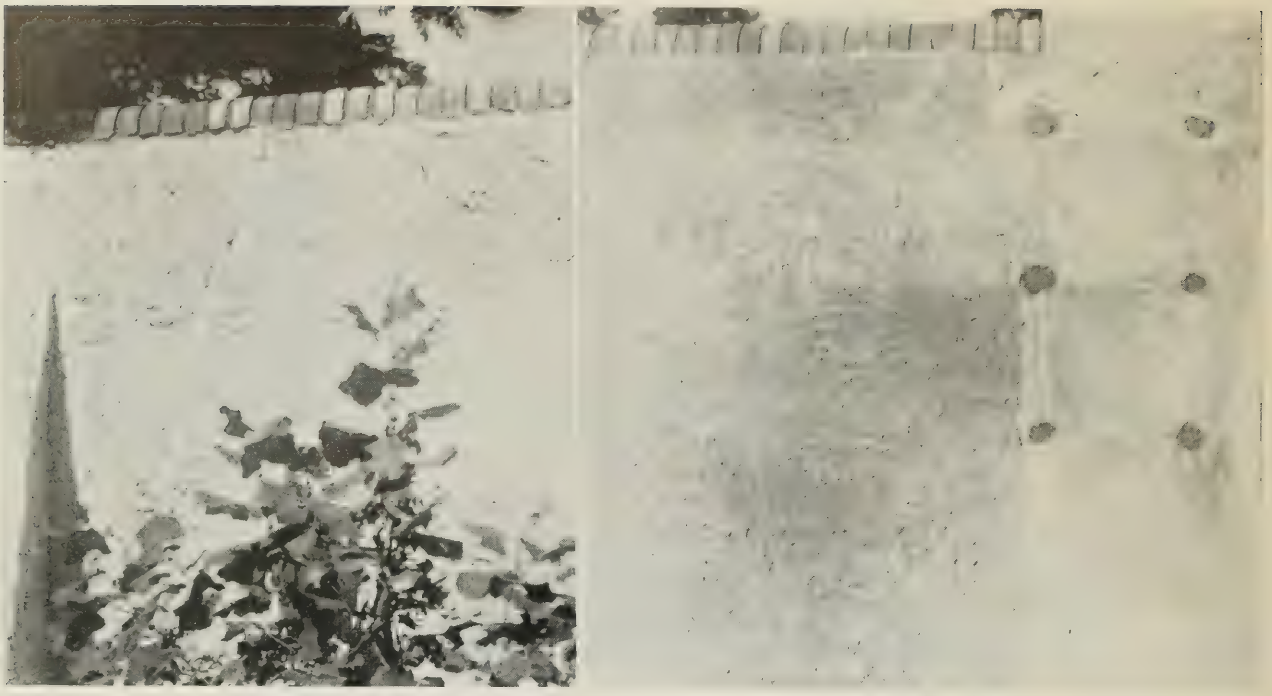
Pennsylvania so far exceeds all the rest of the states in the value of its mineral products as to stand almost alone. Exclusive of the value of pig iron, coke, and other derived or secondary products not included in the total, the value of Pennsylvania's mineral production is nearly one-fourth that of the entire country; and in 1913, according to figures of the U. S. Geolo. Survey, computed in co-operation with the Pa. Topographic and Geologic Survey Commission, it equaled the combined value of the production of W. Va., Ill., Ohio and Cal., the next four states in the value of their mineral product.

Pennsylvania derives its mineral wealth almost entirely from non-metalliferous mining operations. Second in importance among Pennsylvania's mineral industries is the manufacture of Portland cement. The production of cement in 1913 was 28,060,495 bbls., valued at $24,268,800, against 27,625,340 bbls. valued at $18,945,835, in 1912.

The Geological Survey report also states that the Portland cement industry took second place among Indiana's activities in mineral production in 1913. Production increased from a little less than 10,000,000 bbls. in 1912 to about 10,250,000 bbls. in 1913.

Care must be taken to have well laid out and well supported runways for the wheelbarrows or carts, so as not to displace the forms or reinforcement.

In no case should fresh manure be placed over very green concrete to protect it from freezing, as it will spoil the surface of the concrete.



Figs. 1 and 2—A Garden Wall of Concrete With Slap-dash Stucco Finish and at the Right Egg-Shell Finish and a Section of Unfinished Wall. The Stucco is ¼″ Thick (Average) and Cost 15 Cts. Per Sq. Yd. for Material and Labor

A Feature of this finish and in practically all of the other stucco finishes put on under Mr. Haga's direction is in the fact that workmen are not permitted to "fuss" with their work. It has been very hard to get them to press on the stucco firmly with one free stroke and then *let it alone.* But that is what is done on nearly all of the Haga work. In Fig. 2 the holes where the spacing rods for the steel form sections were driven out have been pointed and the surface is ready for stucco

Thin Stucco Finish on Garden Walls and Buildings Near Middleburg, Va.

(Contributed)

In the mind of even the laymen who has watched the construction of a house of reinforced concrete, there is no question of concrete's superiority as a structural material, but we must recognize the fact that if the reinforced concrete house is to take the place which it deserves in the building world a radical change must be made in its appearance and exterior treatment.

The demand is for a finished, workmanlike surface as it comes from the forms and the writer wishes to acknowledge frankly that with the usual methods this has seemed almost unattainable.

We can theorize on the artistic side and argue that the exposed aggregate is the true concrete surface, or we may satisfy ourselves with the reasoning that the form marks should remain and show, being natural to this way of building, or we may go further and use a tooled surface. But while these wall finishes may be excellent for some types of houses, I believe that all builders who have tried these methods of finish know the difficulties encountered and have often themselves been disappointed in their results obtained.

Stucco and rough-cast surfaces seem especially suited to concrete buildings and offer great artistic possibilities, but in many instances in which this material has been applied in the usual way, the stucco has come loose and peeled off, and it is generally considered difficult to apply stucco over concrete so as to produce a good, permanent finish.

It is a common saying in these times that while man is saying that a thing cannot be done he is quite likely to be interrupted by another man doing it, and this is true in stucco over concrete, and "the man who made it stick" is none other than a Virginia builder operating in a rural section of Landam Co., 12 miles back from the railroad.

The work of C. H. Haga has been illustrated in this magazine before,[1] but in the past three years his work has constantly increased in scope and while he started in the construction of small cottages and farm buildings, the Haga-built houses have been established as a standard for the entire section and are sought for by the rich and poor alike, not because they are cheap but because they are the best that money could buy. The fine exterior finish and consequent attractive appearance are not the least of the reasons for this phenominal success.

To obtain straight smooth walls, as well as for economy in erection, Mr. Haga has used on all this work one of the standard makes of pressed steel wall forms,[2] equipment which he has already used over hundreds of times without apparent damage.

On the first buildings he was careful to have the stucco applied while the walls were green, but in the later buildings he has found this precaution unnecessary and often the stucco has not been put on until months after the walls were up. At first the wall was roughened to give bond but this was also found to be unnecessary, and the finish was applied on the smooth surface, just as left by the steel forms. Work of this sort has been done at all seasons of the year except in the dead of winter.

To test the bond the writer has

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[1] January, 1914, p. 6

[2] Morrill System

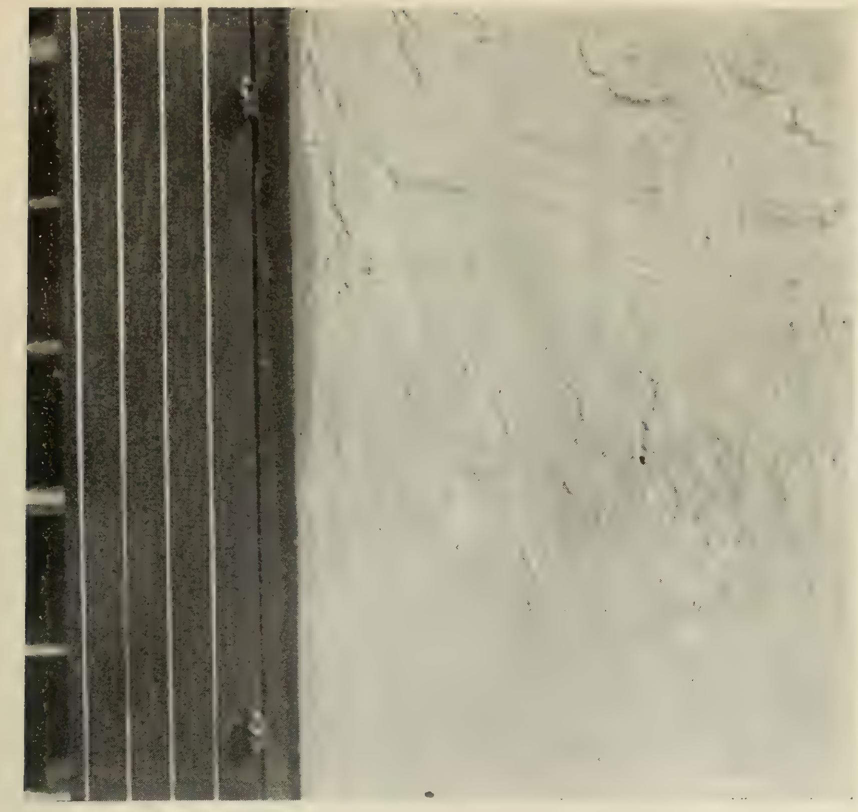

Fig. 3—So-called "Trowel Float" Finish. The Surface is Not Touched After First Application of Stucco

tried to remove the stucco in several places on the various buildings, but invariably the chisel takes a part of of the concrete off with the finish, showing a perfect bond. It is hard to account for this except by the fact that the coat is only put on $1/8''$ to $1/4''$ in thickness and does not act in the same way as a heavy thickness of stucco.

First, the wall is thoroughly drenched about an hour before the work is applied and again immediately before the work is started. White or gray Portland cement is used with clean sand or stone dust. It is applied with a steel trowel but great care is taken ont to touch the work after the first stroke. This gives that free, almost careless appearance so characteristic of the best Italian stucco finish, and the walls have a uniform, workmanlike appearance, yet show great variety, as no two spots are alike.

The stucco mix is 1 part cement to 1 part sand or crushed stone, with 10% by volume of hydrated lime added. In warm weather the stucco is sprinkled and kept damp until it has set up quite hard. Coloring matter, when desired, is mixed in the mass but enough is mixed dry for an entire side before the work is started. The work is done by plasterers. The cost of the material with white cement is a trifle less than 6 cts. per sq. yd., and the labor cost is about 9 cts. per sq. yd., so that the total cost of this attractive finish has averaged only 15 cts. per sq. yd.

One of the advantages of the rough surface is that any slight imperfections in the wall or stucco do not show and in one of the buildings an extra rich mix was used in the stucco and it was applied in hot weather.

Much of the work on the various buildings has now stood perfectly for nearly three years, and shows no defects and seems to be as hard and permanent as the wall itself.

Testing Cinder Concrete Floors

By Harold Perrine[1]

In the year 1896 methods of tests were adopted by the N. Y. Bldg. Dept. with a view to controlling the design of floor systems which consist essentially of arches or slabs placed between steel beams. Primarily, these tests consisted of the standard fire, water and 600-lb. load tests leading to 150-lb. safe live load approvals. To eliminate the necessity of further elaborate tests, when the manufacturer desired approvals of longer spans and greater loads than those previously constructed for fire test, the so-called "arbitrary" load test was adopted. Although this was not, perhaps, in the present state of our knowledge, the most scientific and economic method to pursue in the establishment of safe working loads, it served its purpose in the absence of other data. As it happened, a major portion of these types of construction thus tested were of cinder concrete.

This method of testing typical units is not, in the writer's opinion, deserving of all the adverse criticism that is often heaped upon it. If the test is conducted intelligently, under proper auspices and with the employment of definite load concentrations, much can be learned therefrom. In fact, it is only through a series of such tests as a basis of reasoning, together with a thorough knowledge of cinder concrete, as such, that proper steps in the right direction can be taken.

In a paper on this subject read recently before the A. S. C. E.,[2] the author of the paper seems entirely to lose sight of the fact that the great mass of cinder concrete construction in N. Y. C. is not installed in the form of true continuous beams. Seemingly without proper investigation of the obstacles to the application of accepted formulas for design, he makes careful and painstaking analysis of many of the present forms on this assumption, with the result that he finds many systems overloaded. Although it is true that many designs have been approved for excessive live loads, according to the accepted theory, many others, chiefly those in which the reinforcement is continuous and securely anchored, are within safe limits due to the catenary or, possible, even to the true arch action which these types offer. For, the facts to be considered in analyzing many of the approved types are extremely difficult to determine and, in fact, they offer an extensive field for scientific research.

It is entirely feasible for any city to establish working stresses to be used in cinder concrete construction between steel beams, requiring a minimum limit in compressive strength upon standard specimens. But each city should probably do this independently in view of the fact of the variableness of the clinkers available. Also, the source of supply of the clinkers and the conditions obtaining at the source are details of inspection equally important as a knowledge of the source of supply of any coarse aggregate. Proper inspection of the sand to be used cannot be too rigidly enforced.

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[1] Civil Engrg. Dept., Columbia Univ., N. Y. C.

[2] "Cinder Concrete Floors," by Guy B. Waite, Proc., A. S. C. E., Vol. 40, No. 4, April, 1914

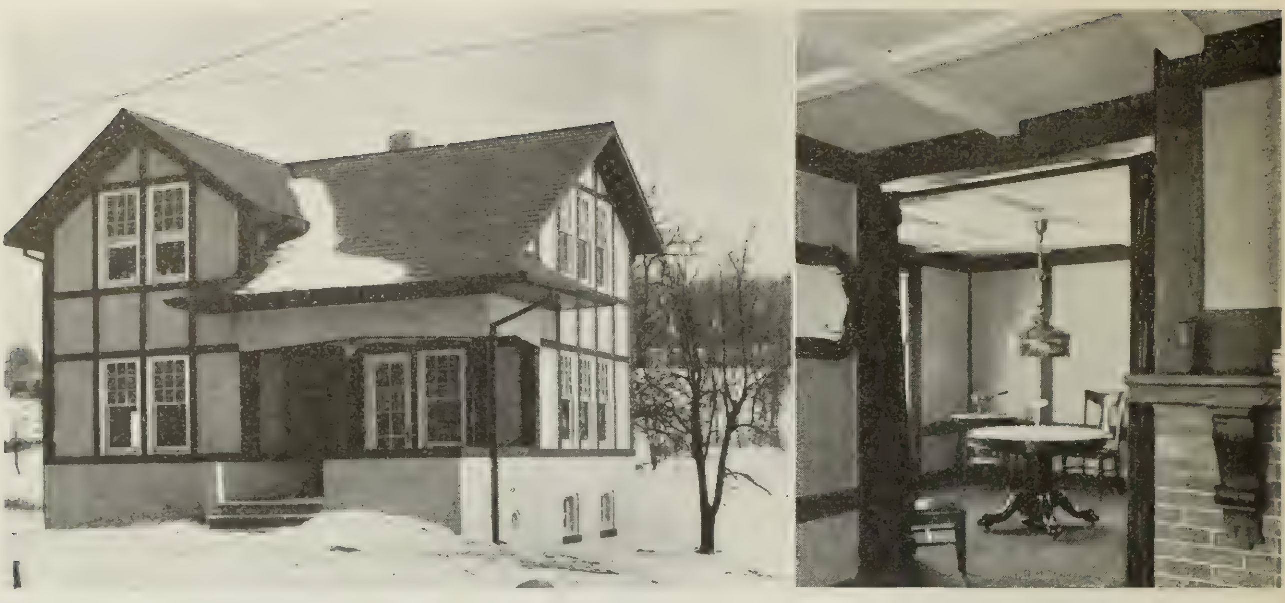

FIG. 1—COMPLETE HOUSE BY SIMPSON METHOD OF UNIT CONSTRUCTION AT NEW DURHAM, N. J.

At the left is an exterior view. All portions of building showing dark are of concrete, the vertical parts cast in the field; all horizontal dark portions and the light-colored panels were pre-cast. At the right is an interior view. Studs and false beams of ceiling were cast in place, other parts were pre-cast. See Fig. 5, a view from the same location while building was being erected

Double-Wall House Construction With Pre-Cast Wall, Floor and Roof Units

A new type of construction for fire-proof homes, the invention of John T. Simpson,[1] (who supplies this description) consists in making buildings of reinforced concrete practically without forms, the greater portion of the work being pre-cast and of minimum sections, made with the idea of using common labor in erection. No plaster or stucco is used. All outside walls, partitions, floors, etc., are hollow, for protection against moisture and frost and for insulation.

The construction consists of wall, partition, ceiling, floor and roof slabs, together with belt and sill courses, floor beams and roof rafters, which are made of standard sections and sizes for the individual pieces, but which may be assembled in any combination desired, so that while each building is made up of standard units the general design may be varied, making it unnecessary to produce buildings all of which are alike in general design and outline.

The footing courses are cast in place as are also the studs of the walls and partitions, together with the false beams of the ceilings.

The pre-cast sections of the building are made on casting tables or in molds. This may be done either at the building site or in a yard or a shop and shipped to the site. If the latter method is adopted, the sections may be packed in fine broken stone, sand or gravel, to be used later at the site to form the studs.

All of the pre-cast members entering into the construction are so designed that the metal with which they are reinforced projects beyond the end or the edges of the finished pieces. In assembling the pre-cast sections at the buildings, they are spaced at intervals at the walls and partitions, leaving a space between every two sets of sections, and are clamped together temporarily by means of channel-shaped wood or metal forms covering the two open sides of the intervening space and forming a pocket into which reinforcing bars are placed, and the pocket filled later with concrete, forming the studs and binding all of the parts together.

The reinforced concrete beams of the floor construction rest upon the top of the wood forms of the studs, permitting the ends of the concrete beams with their reinforcement to project into the pockets, so that when the casting is complete each beam rests directly upon the stud, and is securely anchored.

The ceilings are formed by reinforced concrete slabs, the sides of which rest on the bottom flanges of the floor beams, which are specially designed for that purpose, a space being left between the ends of each slab into which the reinforcement of these slabs projects. When the ceiling slabs are all in place, channel-shaped forms of wood or metal similar to that used for studs but properly notched at intervals to cross the floor beams are placed under the openings between the ceiling slabs and in line with the wall studs, forming pockets, open at the top, and through these concrete is poured unshaped forms of wood or metal simitil it overflows above; thus there are formed false beams at right angles to main beams, closing the openings between the ceiling slabs.

The floor slabs are placed directly on top of the floor beams with the reinforcement projecting from the ends, forming a groove on top of the floor beams which is later filled with cement grout binding the slabs together. The cross-joints of the slabs are brought tight together. On top of these slabs is placed the finished floor, which may be either of cement finish, plastic materials or the standard wood floor on sleepers. Upon the removal of the forms of the false beams and studs, the exposed faces are touched up with wood or steel float, according to the finish desired. This is the only work required to complete the building.

The roof rafters and roof slabs

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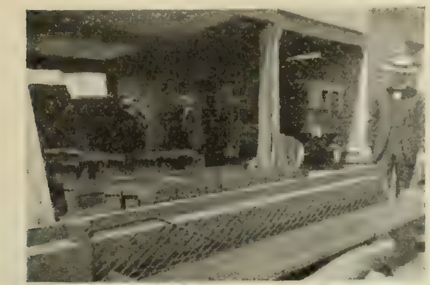
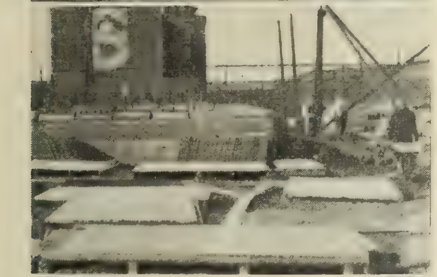
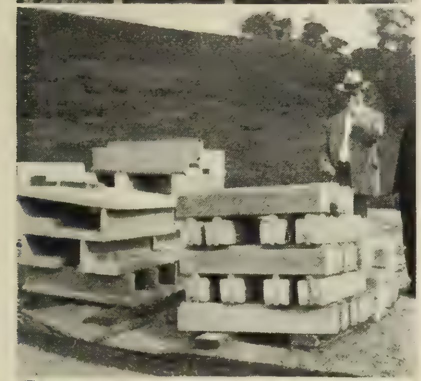
[1] Archt. and Engr., Newark, N. J., System Patented

are placed in the same way as the floor beams and floor slabs, the roof slabs having nailing strips embedded in their upper surfaces for securing slate or tile or to be finished smooth in case felt roofing or asphalt shingles are used.







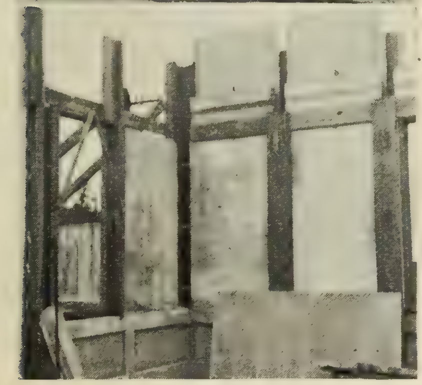


Fig. 2—Beam Mold in Casting Yard With Reinforcement in Place, One Side of Mold Open to Show Interior

The end pieces make the forms adjustable as to length, the sectional dimensions remaining the same for ordinary house work.

Fig. 3—Casting Yard for Houses Built at St. Johns, P. Q.; Casting Tables in Foreground

Fig. 4—Sill Course and Stair Sections in Yard at New Durham

Fig. 5—House at New Durham Under Construction

Walls are complete to first story window sills; window frames in place; at the right the inner and the outer panels are in place, held by the field forms; top ends of interior stud forms are used to support end of floor beams.

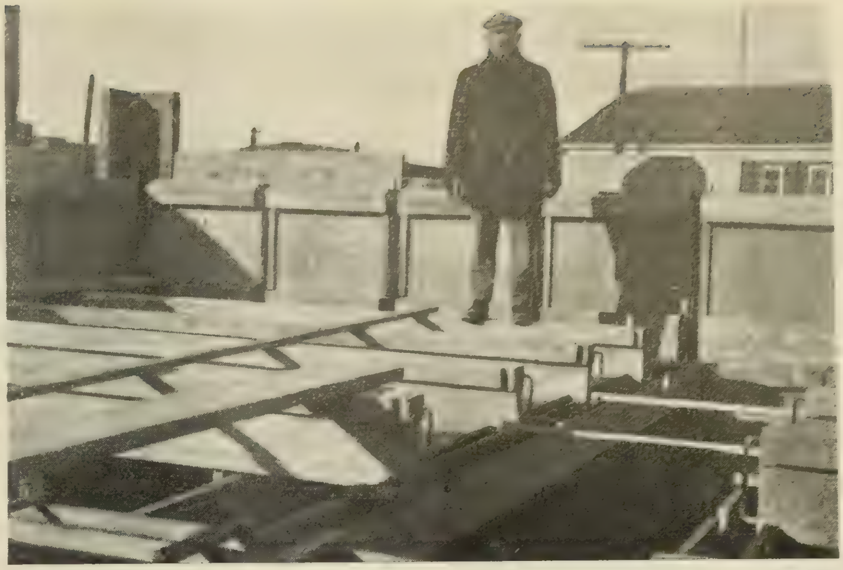


Fig. 6—One of a Group of Four Houses Under Construction at St. Johns, P. Q.

Pre-cast floor beams are in place supported at one end as shown in Fig. 5 and at the other by a wood form which makes a band at the tops of all partition studs. In the center just a glimpse of the ceiling slabs is given. These are grouted at the edges.

The chimneys, mantels and stairs are all pre-cast and built in as the building progresses, the reinforcement projecting at the ends in such a manner as to be cast in with the studs.

Walls may be built either with solid slabs, two slabs with air space, or three slabs with two air spaces. The first type of construction is intended largely for small buildings on the farm, garages, etc.; the second for general home construction throughout the U. S., and the latter for more northerly home construction to withstand severe winters.

In construction the standard sizes of the sections are about as follows: Walls and partitions slabs 1″ in thickness, with reinforcing flanges on the back. Ceiling slabs 1″ and floor slabs 2″ in thickness.

Roof slabs 1½″ in thickness, with molded verge pieces around the outside edges of roof.

The belt and sill courses are generally 5″ on the face, and 8″ in width of wall. Floor beams are 12″ in depth, with the bottom flange 2″ x 5″, a web 3″ in thickness and top flange 3″ x 8″. The stairs are formed with a tread and a riser in one piece, tread being 1½″ in thickness and riser 1″ in thickness. Roof rafters are of the same general form as the floor beams, with the exception that the ends form outlookers, which are generally 3″ x 10″. The reinforcement used for the wall slab work throughout is Clinton[2] welded wire 2-in. x 2-in. mesh for walls, partitions and ceiling slabs, 3-in. x 4-in. mesh for floor and roof slabs. Welded wire 3-in. x 4-in. mesh is also used in the belt and sill courses and lintels.

The beams and studs are reinforced with deformed bars of ½-in. by ½-in. section and Clinton welded wire.

The ends of the reinforcements in the belt courses are arranged to lap around the vertical reinforcing bars in the studs and hold them in correct position while the concrete is being poured.

In the outer edges of all wall studs are placed paper tubes which are held in place during casting by the welded wire of the wall slabs. These tubes provide air spaces as an extra precaution to prevent dampness and frost from penterating through the studs.

The pre-cast sections are either of sand and gravel to pass through a ¼-in. or of fine stone screenings 4 parts, and Portland cement 1 part. The concrete of the wall studs, false beams, etc., is made of the same proportions.

The standard spacing adopted for studs and beams is 3′ 3″, which permits the use of a door or a window 2′ 8″ wide. The studs and beams are 5″ in width on their faces, though a wider or a narrower unit can be used if desired.

The exposed surface of the members forming the building can be of any finish desired, either smooth under steel float, sand-finish under wood float, or acid-treated as may be desired. Different methods of coloring can also be used for facing and for

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[2] Clinton Wire Cloth Co., Clinton, Mass.

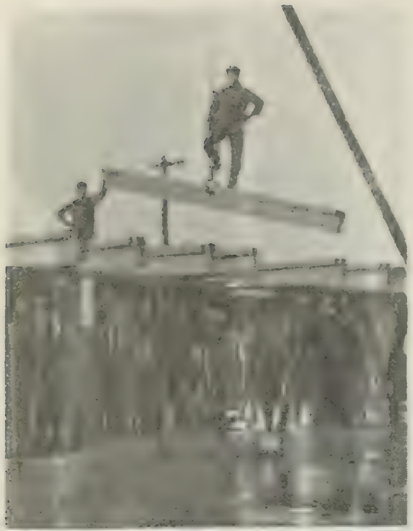


Fig. 7 Lifting Floor Beams Into Place on St. Johns Work

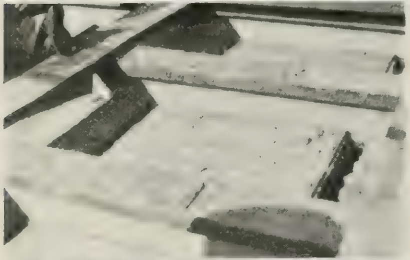


Fig. 8 Ceiling Slabs in Place

Joints are shown where false beams are cast to give paneled ceiling necessary to cover up the joints between ceiling slabs

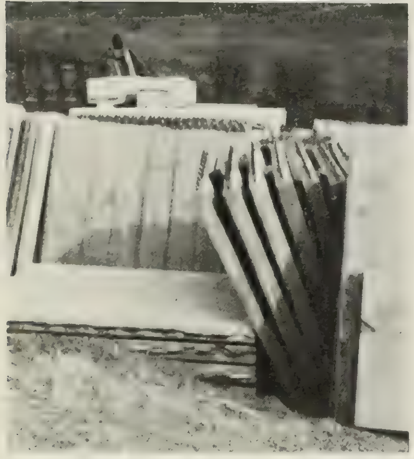


Fig. 9 Sill Courses and Floor and Ceiling Slabs Curing

exposing the aggregates. The standard method of finish, however, is smooth for panels and interior work; wood float for studs, sill courses, etc., on the exterior.

The concrete forming the exposed walls is waterproofed by introducing 5% of hydrated lime into the concrete, and further waterproofed by treating the entire exterior surface of the building with Cabot's cement stain.[3] tinted in colors as desired. The interior of the building is finished with washable wall coatings.

A fire-place of brick with tile hearth may be used if desired, instead of concrete mantels.

This description applies to the standard Simpson-Craft construction, producing panel construction on both the exterior and the interior of the building. This may be varied, however, by the use of flat surface for both exterior and interior treatment of walls. For exterior walls the outside surfaces of wall slabs, belt and sill courses are cast very rough on the portions desired to be flat, and after the building is erected are covered with a coat of stucco. For the interior surface the walls and surfaces may be finished by either of two methods: First, forming the interior surface of the pre-cast members rough and covering with a coat of white plaster; Second, by furring off the inside of the walls and ceilings with stiffened metal lath attached by wire "hairpins" previously built into the studs and plastered in the ordinary manner, securing to the metal lath any nailing strips desired for the trim.

In the standard construction, provision is made for hanging pictures by building in a strip of folded metal forming a groove into which the picture hooks may be placed. Where wood frames are used for windows they are set and built in as the construction proceeds.

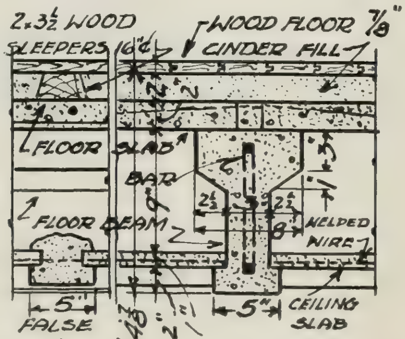
Door frames may be secured either by dove-tail blocks built into the studs when cast or by expansion bolts, and all openings for heating and plumbing pipes are formed in the sections during casting. The gas pipes and electric conduits are laid on top of the floor slabs before the finished floor is laid or placed in studs for side lights before these are cast.

The wood used in these buildings is confined to the finished floors, doors and windows, though steel sash may be used to deplace the latter.

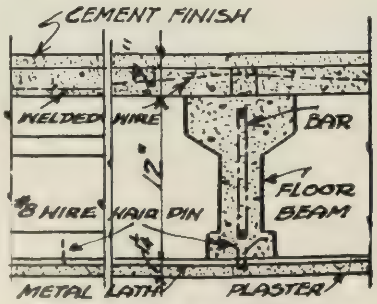
This construction is intended to compete with wood frame.

After the broken stone and sand are delivered at the site, keep them in separate piles and do not allow dirt from wagon wheels to mingle with the aggregates.

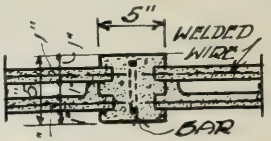
Slaty or shaly rocks are not good material for concrete aggregate and should be avoided.



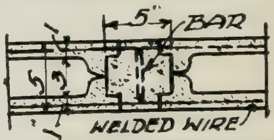
FLOOR CONSTRUCTION
PANELED CEILING.



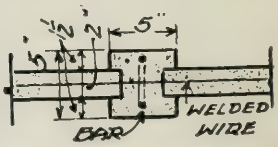
FLOOR CONSTRUCTION
FURRED AND PLASTERED CEILING.



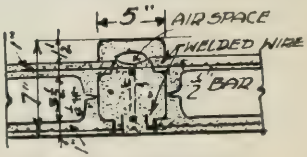
PARTITION CONSTRUCTION
PANELED BOTH SIDES



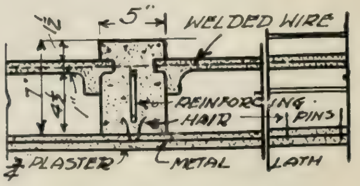
PARTITION CONSTRUCTION
FLUSH BOTH SIDES



GARAGE WALL CONSTRUCTION
SINGLE SLAB



WALL CONSTRUCTION
PANELED OUTSIDE



WALL CONSTRUCTION
PANELED OUTSIDE
FURRED & PLASTERED INSIDE

Fig. 10—Details of Construction Units and the Way They Are Assembled

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[3] Samuel Cabot, Inc., Boston

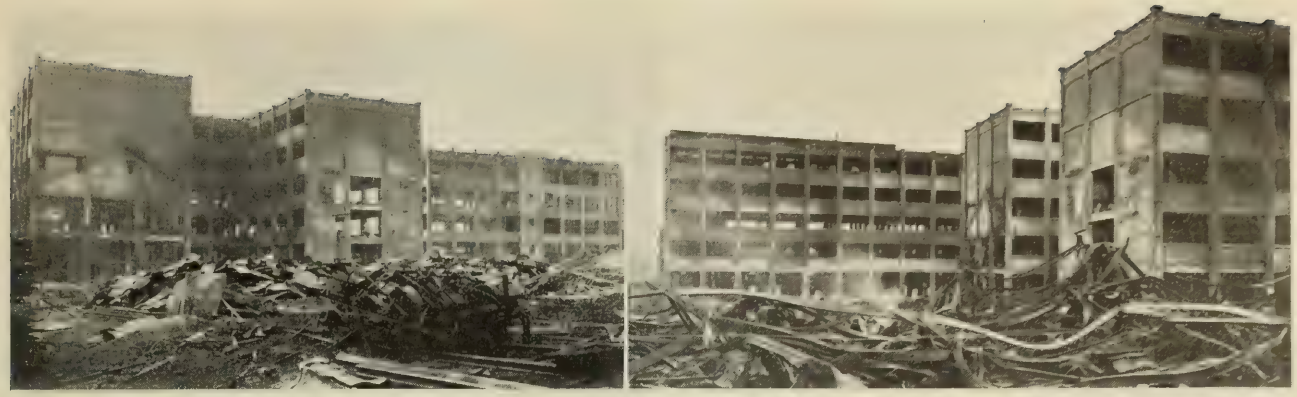

Fig. 1—Reinforced Concrete Buildings of the Edison Factory, West Orange, N. J. Survivors of the Dec. 9 Fire. Debris and Other Types of Structures in Foreground

The Fire-Resisting Qualities of Concrete Buildings at the Edison Factory, West Orange, N. J.

One of the most disastrous fires that ever occurred in a manufacturing plant destroyed a large part of the plant of Thomas A. Edison, Inc., at West Orange, N. J., on the evening of Dec. 9, 1914. The quick collapse of ordinary window glass in wooden sashes made openings everywhere and the fire swept unrestrained through about 14 buildings, with an estimate of property loss at about $2,000,000. Fig. 1 shows a partial view of the ruins of the Edison plant.

THE FIRE

The fire started at about 5:20 p.m. in the film inspection department, a one-story, sheet iron structure, located about the center of the plant as shown in Fig. 2, and rapidly spread to the immediately adjacent low brick shops and storage houses. The contents of these proved such effective fuel that the fire soon spread into and through the reinforced concrete buildings which contained wood used in the manufacture of cabinets, celluloid for films and wax for phonograph records, chemical supplies, phonograph disks and cylinders, packing boxes and other material of highly inflammable character.

The fire very seriously damaged 11 buildings and burned over an area of nearly six acres in which these and other buildings were located. It was confined, however, to a city block as shown by the plan in Fig. 2; this is only a part of the plant, there being five other buildings north of Alden St., and a storage battery building south of Lakeside Ave.

The inadequacy of the 800-gal. per min. well on the premises and that of several 6-in. pipe lines leading from a single 8-in. main of the West Orange water supply system were the principal reasons that may be assigned for the extent of the disaster and the rapidity of the progress of the fire. The forced cutting off at the power house of the current for the pump-motor soon put the well supply out of commission. Streams from the West Orange supply were not equal to the emergency and only with difficulty were the groups of buildings at either end saved.

Automatic sprinklers were lacking where they should have been installed, and none of the buildings was equipped with wire-glass windows in metal frames.

EFFECT OF FIRE ON CONCRETE BUILDINGS

The seven concrete buildings (varying in height from four stories to seven stories) attacked still stand, while many of the buildings were of a type of construction that made their destruction easy for the flames. The view in Fig. 1, overlooking the site of the initial fire, shows the complete destruction wrought. The buildings of brick and steel completely collapsed, resulting in a twisted mass of ruins, and the effect of the fire on these structures has nothing of novelty.

The concrete buildings, on the other hand, tell with clearness the interesting story of the Edison fire. With the exception of certain sections in the phonograph record department and the assembly department, (see Fig. 2), the buildings appear to be in good condition, although the fire readily broke through the glass windows and, aided by the inflammable contents and wooden trim, soon destroyed everything except the concrete frame.

So hot was the fire that not only were the wooden floors (supported on wooden sleepers embedded in the concrete) entirely consumed, but no evidence of the sleepers or strips re-

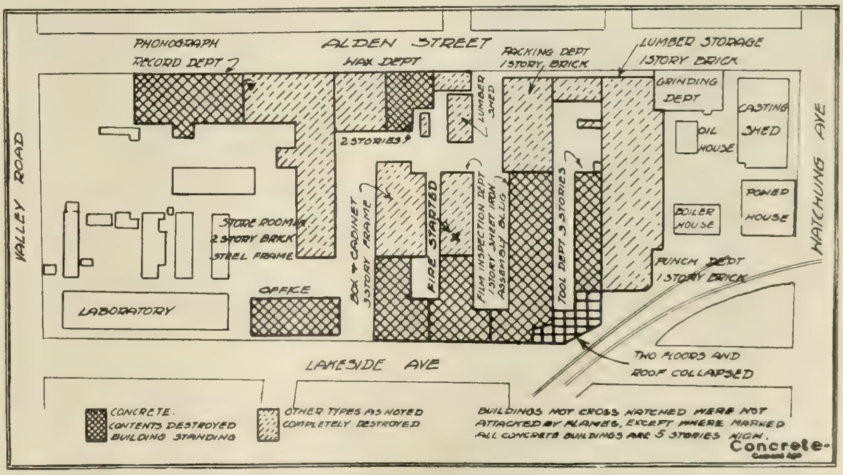
PHONOGRAPH RECORD DEPT
ALDEN STREET
WAX DEPT
PACKING DEPT 1 STORY, BRICK
LUMBER STORAGE 1 STORY BRICK
GRINDING DEPT
CASTING SHED
LUMBER SHED
2 STORIES
OIL HOUSE
VALLEY ROAD
WATCHUNG AVE
STORE ROOM 2 STORY BRICK STEEL FRAME
BOX + CABINET 3 STORY FRAME
FIRE STARTED
FILM INSPECTION DEPT 1 STORY SHEET IRON
ASSEMBLY BLDG
TOOL DEPT 3 STORIES
BOILER HOUSE
POWER HOUSE
PUNCH DEPT 1 STORY BRICK
OFFICE
LABORATORY
LAKESIDE AVE
TWO FLOORS AND ROOF COLLAPSED
CONCRETE. CONTENTS DESTROYED BUILDING STANDING
OTHER TYPES AS NOTED COMPLETELY DESTROYED
BUILDINGS NOT CROSS HATCHED WERE NOT ATTACKED BY FLAMES, EXCEPT WHERE MARKED
ALL CONCRETE BUILDINGS ARE 5 STORIES HIGH.
Concrete-Cement Age

Fig. 2—Plan Showing Location and Type of Buildings Attacked by Fire at the Edison Factory, West Orange, N. J.

Cross-Hatchings indicate the extent of the destruction wrought by the fire of Dec. 9, 1914. The fire started from the point marked by a cross which is located almost exactly in the center of the group of buildings main other than the grooves in the concrete and the nails which held the floor down. In spite of this heat the concrete slabs in almost all cases are in perfect condition.

Cracks close together are found across the bottoms of beams where the fire was hottest, being especially noticeable in the phonograph and record department, where also the cracks between floor-beams and the under side of floor-slabs are easily seen, being expected from the fact that the beams and slabs were not poured at the same time.

The heat in the first floor of the assembly building was so intense, due to a large stock of phonograph records and crated phonographs awaiting shipment, that it caused the concrete columns to become almost a pure white (as contrasted with the discoloration and blackening elsewhere), the soot ordinarily deposited being consumed. Throwing water on this floor at the height of the fire, caused some of the columns to spall and buckle badly as shown in Fig. 3, 1½″ being the usual depth of spalling. Longitudinal cracks are also found on many of the columns. The concrete in the upper floors is in good condition.

The straight-rodded reinforced concrete column, consisting of four vertical bars only, without horizontal ties or hooping, was inadequate to prevent shearing failure in some instances, thus causing the columns to buckle and break in an unprecedented manner. Such columns are dangerous in a hot fire.

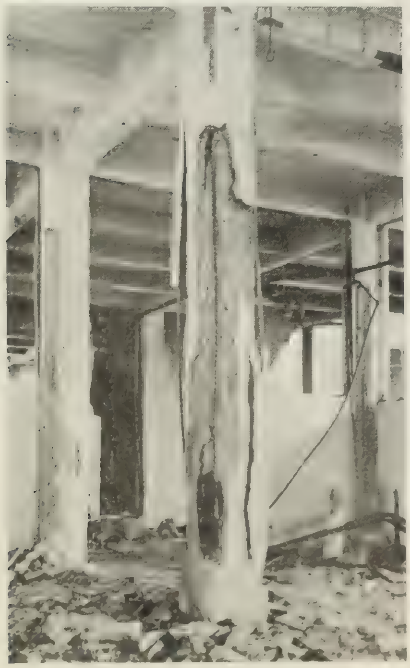

Fig. 3—Condition of Columns, First Floor, Assembly Building

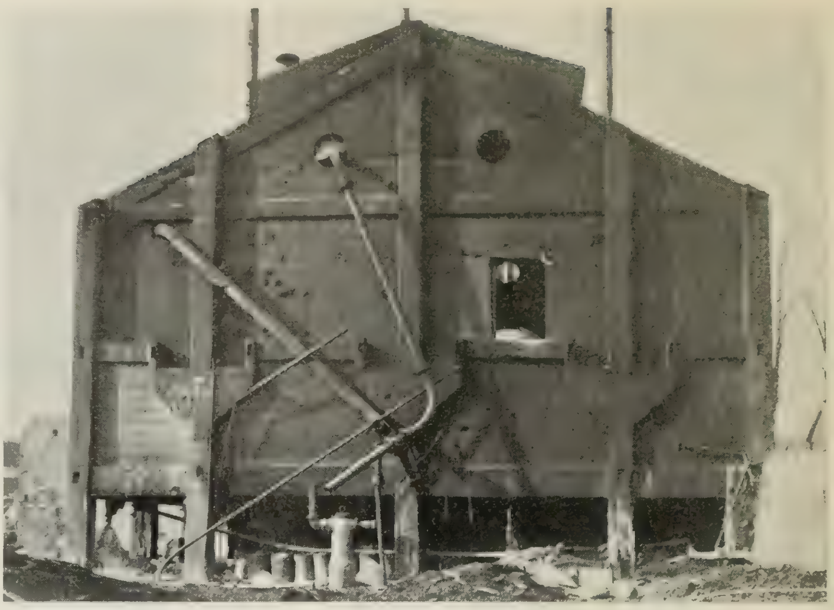

Fig. 4—A Conspicuous Example of the Fire-Resisting Properties of a Reinforced Concrete Building

This building contained a large quantity of the wax used for cylinder records and was subjected to intense heat. Surrounding it is the tangled wreckage of adjacent buildings entirely destroyed by the fire

The two upper stories of one of the five-story buildings collapsed, indicated in Fig. 2, because of a heavy overload of machinery and castings. When the water was applied to the hot columns, they did not have strength enough to hold up the load. The lower floors, however, took care of the extra load and the shock of the falling material.

EFFECT OF WATER

The impervious concrete floors afforded protection to the contents of separate departments or floors, it being difficult to find even damp spots on the ceilings or under parts of the floors subjected to the hottest fire and the greatest amount of water.

CONCLUSIONS

Considering the fact that these buildings were among the first of the reinforced concrete buildings built in this country (from 5 yrs. to 7 yrs. ago), and before the time that reinforcing was as well understood as it is today, we quite agree with Mr. Edison that the results of the fire are "a triumph for concrete," as it is hard to imagine any fire where the heat would be more intense, due to the inflammable character of the materials.

The report of three specialists shows that about 87.5% of the concrete buildings are in good condition. Not a concrete building need be entirely demolished.

Another interesting fact is that in the concrete buildings the salvage of the machinery is about 85% and a great deal of it will need very slight repairs to put it in operation. In fact, some of it is already in operation.

Concrete mixers must be kept clean. Before stopping at the noon hour the mixer should be thoroughly washed out, and again at night.

Hemlock when used for form work is liable to split in nailing and to curl on account of the moisture from the wet concrete.

Concrete columns should be poured from the center, the operation being continuous from the base to the under side of supported beam or guide.

Vaulted roofs should be laid in alternate squares, the lines of division being through the crown of the groined arches.

When concrete surfaces are discolored as a result of smoke, soot and similar impurities, it is sometimes possible to remove the accumulation by applying naphtha. If this fails, a light application of sand-blast will entirely remove the discolored surface.

Field Methods in Concrete Construction—A Consideration of Materials

By Jerome Cochran, C. E.

Although concrete is today used to advantage in several hundred different commercial forms, ranging from great engineering structures, containing thousands of cubic yards of material, to a fence post containing only a very small fraction of a cubic yard, it is somewhat difficult to find in print a series of rules and directions relating to field methods in concrete work. It is generally assumed by writers that standards or methods of construction in this class of work have been long ago established and have become common knowledge. The series of articles, of which this is the first, has been planned in opposition to this assumption. The articles will describe current practice in concrete construction from the contractor's viewpoint. This first article relates to concrete materials. It will be followed by articles on the proportioning and mixing of concrete; forms and centering; steel reinforcement; transporting and placing of concrete; finishing concrete surfaces; and waterproofing concrete work.

CEMENT

Careful inspection of cement should not be considered purely as an additional refinement in connection with concrete construction, but as an absolute necessity, even though there be a tendency among cement manufacturers to improve the quality of their material.

Sacks or barrels should be plainly marked with the brand or trade-mark of the manufacturer of the cement. Reject packages containing a large portion of lumps.

Weather-proof store houses, with floors raised above the ground, should be sufficiently large to permit easy access to the different lots of cement for proper inspection, sampling and identification, the date of receipt being plainly indicated. Storage of cement in the open should be limited to small quantities to be used immediately in the work, planking and tarpaulins being used as protection against wet ground and showers.

If the cement becomes lumpy before being used, it should be thoroughly pulverized, care being taken to pick out all lumps that cannot be broken up with a light blow of the shovel.

The selection of the sample of cement for testing, the number of packages sampled and the quantity taken from each package are usually left to the discretion of the engineer. Cement in sacks should be sampled from the surface to center. If in barrels, it may be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or a sampling iron similar to that used by inspectors of flour or sugar.

Pats and balls of neat cement, and of cement mixed with sand, should be made from time to time in order to be certain that the cement going into the work is uniform in character. The setting or hardening qualities may be determined roughly by estimating time and by pressure of the thumb-nail. The test for hardness of the set and strength is made by cracking the hardened pats or cakes between the fingers, and by dropping the balls from the height of the arm upon some hard substance and observing the result of the impact. Some idea of the character of the material,—whether hydraulic cement, Portland, Natural or Puzzolan, whether too fresh or possibly "blown," may be speedily and quite well ascertained by observing the character and color of the fracture of the hardened pats after sufficient immersion in water raised to the boiling point for a few hours.

FINE AND COARSE AGGREGATES

It is to be regretted that contractors have not more generally acquainted themselves with the value of various aggregates, as regards their adaption for use in concrete work. While the selection is ordinarily governed by the materials obtainable in the locality, careful consideration should be given to the character of the work and the desired qualities in the finished construction.

Material direct from the crusher or bank may be used without screening and subsequent mixing, provided it is suitable for the purpose as regards gradation, cleanliness, etc.

The washing of aggregate for small jobs may be done in almost any type of batch mixer by simply revolving the mixer and letting the hose play inside without stopping. The mixer in overflowing carries off the foreign matter in the water. For larger jobs, however, other arrangements should be made.

It is especially necessary to provide platforms in important street pavement work for sand, gravel or broken stone. If deposited upon the earth, difficulty will be experienced in avoiding taking up earth and mud with the materials.

SAND AND STONE SCREENINGS

Fine aggregate, consisting of sand, crushed stone or gravel screenings, should show no indications of chemical decay. Sea-sand should be freed from salt by washing, or the concrete will effloresce.

Preference should generally be given to the round grained sand, as it packs more closely, affords no opportunity for bridging and gives minimum percentage of voids.

The sand should consist of a mixture of coarse and fine grains with the coarse grains predominating, the largest grains when dry passing a screen of ¼-in. mesh.

The sand must be free from quicksand, clay, loam, mica, sticks, organic matter and other impurities. A rough field test for percentage of loam is to rub the damp sand between the palms of the hands, and then see how much loam can be scraped off. Put a handful on a piece of glass or a piece of clean writing paper and place it in the sun, or near a heater to dry. White paper is best, for that can be rolled back and forth, and leave the fine loam on the edge. A more accurate method is to put a sample of the sand in a bottle, fill it with water nearly to the top, then shake the bottle thoroughly. The sand will settle to the bottom with the dirt on top of it when the mixture is allowed to settle. The amount of dirt can be measured approximately.

Sand showing signs of disintegration, or containing over 5% of mica, laminated particles or loam, should generally be rejected. Sand that has come in contact with alkali solutions or that will not absorb water should be avoided. Sand containing over 45% of voids should not be used to make mortars. Sands producing mortars having a strength of less than 70% of standard Ottawa sand[1] and mortar (1:3) should be rejected.

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[1] This sand may be obtained from the Ottawa Silica Co., at a cost of about 2 cts. per lb., f. o. b. cars, Ottawa, Ill.

GRAVEL

The term "gravel" is sometimes used as meaning a mixture of coarse pebbles and sand, and sometimes as meaning pebbles without sand. The first definition is the more logical, and also the more common, and will be used in this series of articles.

The same general statements regarding the proper selection of a good grade of sand will apply to gravel, except that sand is in a sense more important than gravel.

Gravel may contain particles of soft, friable material which will seriously reduce the strength of the concrete. In some localities, particularly in the foot-hills of the Appalachian and the Ozark mountains, a material, locally called gravel, composed of angular fragments of schist, is found in the stream beds; but such material is said to be unsuitable for concrete, since it is checked and is easily broken.

In reinforced concrete members, such as columns, beams, slabs, etc., the gravel should be of varying sizes wherein the sizes of the pebbles range downward from 1″ to ¼″, preferably not over ¾″ as a maximum in many cases. In members of larger proportions 1¼-in. gravel may be used and in massive work 2-in. or 2½-in. gravel. The proportions of sizes should be such that there is approximately 50% of each size with reference to the next largest.

Gravel should be watched very carefully for foreign materials, such as lumps of clay from stripping the hard-pan strata, sticks, decayed matter, etc. So-called yellow gravel is not necessarily a sign of weakness, as often such a surface discoloration is caused by leachings from deposits or strata of oxide of iron or other minerals.

Great care should be exercised in using naturally mixed bank sand and gravel or lake-run gravel, owing to the likelihood of there being far too much sand for the gravel. It is generally far more satisfactory to screen the sand out of the gravel and prepare the materials in the usual way, the gravel being screened to at least two sizes, separated by a ¼-in. screen.

Do not accept slimy gravel, nor gravel containing many mud balls or a large percentage of gravel cemented with mud. Shale gravel should not be used.

BROKEN STONE

The term "broken stone" ordinarily signifies the product of a stone crusher or the result of hand-breaking by hammering large blocks of stone; but the term may also include gravel.

Many of the points mentioned concerning the selection of good sand and gravel are also applicable to broken stone.

Rocks of volcanic origin should be dense, thoroughly vitrified, not scoriaceous, show a clean fracture when broken, be homogeneous and free from cellular structure. Granite spalls when used as coarse aggregate should be free from sap, seams, dries, cracks, large crystals of feldspar, dirt, argillaceous or organic materials, decomposed particles, and defects of any kind calculated to impair its strength, durability or appearance. Limestone should be dense, uniform and homogeneous in structure and with small, even grains and crystalline texture. Sandstone should be in quality and freedom from defects fully equal to limestone.

Broken stone should be nearly cubical in form, as thin, flat particles will not pack well. The harder and tougher the quality of the rock, the less danger there will be of its splitting into laminated or flaky shapes. The broken stone should consist of particles of variable size from those of the size of the largest sand (¼″) to the largest stones (from ¾″ to 2½″, depending upon the class of structure in which the stone is to be used), so that the small pieces may fill the voids of the large ones. In order to avoid separation of the large stones from the small ones, the whole stone pile, as well as different deliveries, should be well mixed, so that different batches of concrete will be as nearly alike as possible.

Each carload or wagon load of broken stone should be carefully inspected and rejected if it contains quarry refuse, stone dust, more than 1% of weathered rock, soapstone or rotten stone, soft white limestone, slaty or shaly rocks, etc. The stones should not have incipient cracks.

CRUSHED SLAG

Only the best quality of hot-pot slag, free from dust and foreign matter, should be used. It should also be nearly free from sulphur or other injurious agents and must be hard and not spongy or honey-combed. Judging a slag from the analysis of a small sample is not safe, because its composition varies with changes in the operation of the furnace or in the nature of the materials being smelted.

CINDERS

Cinders should be composed of hard, clean, vitreous clinker, free from ashes, sulphides and unburned coal. Those from anthracite coal are usually the best owing to their being harder, generally more dense and less liable to contain injurious amounts of sulphur.

Large clinkers in cinders may be crushed with a large flat hammer or a flat iron concrete rammer on a slat platform set upon a couple of trestles about 2′ from the ground, the platform being constructed by bolting together flat bars of iron, about 1″ x 2″, separating the bars about 1″ with spreaders, and a curb or box rim put around the platform. As the clinkers are crushed to 1″ or less in size, they fall through the slats to the ground.

MISCELLANEOUS MATERIALS

Crushed shale should not be used in reinforced concrete construction, as it frequently contains large quantities of rotten rock in the form of slivers or splinters, with little thickness and body, and is therefore not suited to such work. Broken shale is open to the same objections, though it is likely to be cleaner and freer from rotten rock.

Broken bricks should be from well burnt and perfectly sound and hard clay bricks. They should be free from old mortar and from dust or fine particles.

WATER FOR CONCRETE

Neither muddy water, stagnant water, water impregnated with alkali, nor water discolored by the refuse from factories, sewers, reduction works or the like, will give the best results. The water should be fresh, clean, free from alkalies, oils and organic matter in solution or suspension.

The use of cement as an anti-sand blast is possibly one that is little known. The sand blast in question, however, is not that which is so familiar to all of us, but is quite of another type. When locomotives stand under steel or iron bridges or viaducts, the blast from the stacks throw out gases and numerous small particles of ashes and coal. This when continuously projected against the overhead iron or steel gradually causes its disintegration. "When all remedies fail, try cement," and in this case cement was tried and not found wanting and now it is common practice for railroads to cover the bottoms of their bridges with wire netting or metal lath covered with a coating of sand and cement which it has been found resists perfectly the attack of the gases and also the sand blast coming from the locomotives.

Design Methods in Concrete Construction — Analytical Statics of Simple Beams

By Jerome Cochran, C. E.

There has been assumed, in the preparation of this series of articles on reinforced concrete design, a working knowledge of algebra, geometry and trigonometry on the part of the reader. The higher mathematics will be eliminated, as far as it is practicable, from the work. Methods of designing will be set forth and illustrations of designs given that represent the best modern practice in each case. No attempt will be made to develop new formulas or to originate new designs. In fact, the endeavor will be made to eliminate as completely as possible, the "personal equation," or personal prejudices of the Editors, from the work.

The present article will be devoted to the fundamental principles of analytical statics or equilibrium of forces as applied to external moments for simple beams, such as the principle of moments, reactions for supports and bending moments, because a very thorough understanding of these principles is an essential preliminary to scientific reinforced concrete designing. The next article will consider these principles from a graphic standpoint.

FORCES IN GENERAL

Mechanics is the science that treats of forces and of their effects. A few elementary definitions relating to forces are given below. For more advanced study, the reader is referred to Merriman's books, on Elements of Mechanics, which contains 40 lessons for beginners in engineering, and Strength of Materials, which is the standard text-book for manual training schools. He is also referred to the Text-book of Mechanics, Vol. 1—Statics, by Martin. These works will be found of considerable assistance to those taking up the subject of mechanics for the first time.

Force has both magnitude and direction and may act as pressure, a push, or as tension, a pull. These applied forces of pressure and tension will cause the body to move if they are sufficient to overcome the resisting forces.

Force magnitude is usually expressed in pounds, numerals or letters being used in algebraic work to express this magnitude. The single capital letters P_1, P_2, R_1, R_2, etc.,, are used both as general designations of forces and also as the magnitudes of these forces when the magnitudes are not given numerically. In graphical work more elaborate designations are needed, which will be explained in the next article.

It is usually customary to consider magnitude as being positive; for instance, if in solving an equation the value of a magnitude appears to be negative it is to be understood nevertheless that the force is positive as usual, but that its sense is opposite to that assumed in stating the equation.

Components of a single force are the forces that might be substituted for it without changing the effect.

Forces acting upon a body are said to be *in equilibrium* when they are so arranged in magnitude and direction that the body remains at rest. In other words, equilibrium is that condition of a set of two or more forces, the result of which is that their combined effort on a body produces no change in the body with respect to rest or motion, conditions of rest being considered conditions of equilibrium.

Concurrent forces acting on a body are those that have the same point of application or the lines of direction all meet at the same point. The fundamental principles of concurrent forces are fully set forth in the above mentioned books, and it would require considerable space to explain them in detail in the present article.

Resultant of a system of current forces is a single force that might be substituted for them without changing the effect. If this resultant is *0*, the forces are in equilibrium and the body remains at rest; if a resultant force exists the body moves in the direction of that resultant.

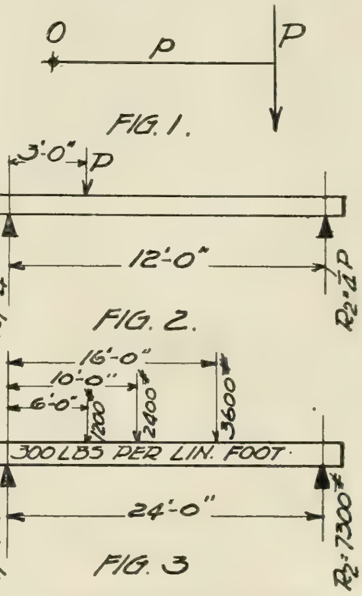
An single force, the addition of which to a set of forces produces equilibrium, is called the *equilibrant* of that set of forces. In other words, the equilibrant of a system of forces is a single force that balances them. The equilibrant is equal and opposite to the resultant. Of a set of forces in equilibrium any one of them is the equilibrant of all the rest. The operation of finding the resultant or equilibrant of a set of forces is called *composition of forces.*

Parallelogram of forces—If three forces acting on a particle are in equilibrium they can be represented in direction and magnitude by a diagonal and the sides of a parallelogram. The "parallelogram of forces" is the name given to the fundamental principles of these graphic operations.

Non-concurrent forces have different points of application and the conditions of oquilibrium for concurrent forces are not sufficient, since they might be fulfilled and rotation still result.

THE PRINCIPLE OF MOMENTS

The moment of force about a point or axis is the product obtained by multiplying the magnitude of the force by the shortest distance from the point or axis to the line of action of the force. Thus in Fig. 1, if P be any force and p the length of a perpendicular drawn to it from any point, the product Pp is the moment of the force with respect to that point. In other words, *Moment* = Force × Perpendicular. As P is in pounds and p is in feet or inches, the moment has a compound quantity which is called pounds-feet or pounds-inches.



Figs. 1, 2 and 3—Sketches Illustrating the Principle of Moments and Reactions of Supports as Applied to Simple Beams

The word moment is here used in its old-fashioned sense of *importance* or *influence;* so that the moment of a force with reference to a point means its influence in producing rotation about this point. In all investigations regarding the strength of beams the principle of moments is of constant application and it will be well for the reader to bear in mind the importance of the subject.

In order to explain the matter further, a beam is considered as a body held in equilibrium by the downward loads and the upward pressures of the support, as shown in Fig. 2. As the beam is at rest these forces are in equilibrium, and the algebraic sum of their moments is zero about any point in the plane. This principle results from the meaning of the word "equilibrium" which implies that the body on which the forces act is at rest; and since it is at rest the forces taken collectively have no tendency to turn it around any point.

The point *O* from which the perpendicular is drawn in Fig. 1, is called the *origin of moments* and may be chosen arbitrarily. This point is also sometimes referred to as the *center of moments*, or, more briefly, the *center*.

Reference is sometimes made to an axis instead of to a point when expressing the moment of a force, meaning thereby the axis of the conceived rotation. Such an axis is considered as a straight line passing through the center normal to the plant of the forces and its arm. The moment with respect to this axis is also spoken of as the moment with respect to the plane which contains this axis and is parallel to the forces.

The algebraic sign of a moment is considered *positive* if it tends to turn the system in the same direction in which the hands of a watch rotate, and *negative* if in the opposite direction. This assumption, however, is purely arbitrary.

REACTIONS OF SUPPORTS

Let a simple beam resting on two supports near its ends be subjected to a load *P* situated at 3′ from the left support, and let the span be 12′, as shown in Fig. 2. Taking the center of moments at the right support, the lever arm of R_1 is 12′, that of *P* is 9′, and that of R_2 is *0*; then by the application of the principle of moments $R_1 \times 12 - P \times 9 = 0$, or $R_1 = \frac{3}{4}P$. Again, taking the center of moments at the left support the lever-arm of R_1 is 0, that of P is 3′, and that of R_2 is 12′; then likewise from the principle of moments $-R_2 \times 12 + P \times 3 = 0$, or $R_2 = \frac{1}{4}P$. The sum of these two reactions is equal to *P*, as should of course be the case.

The reactions caused by the weight of the beam itself may be found in a similar manner, the uniform load being supposed to be concentrated at its center of gravity in stating the equations of moments. Thus, if the weight of the beam be *W*, the two equations of moments are found to be $R_1 \times 12 - W \times 6 = 0$, and $-R_2 \times 12 + W \times 6 = 0$, from which $R_1 = \frac{1}{2}W$ and $R_2 = \frac{1}{2}W$.

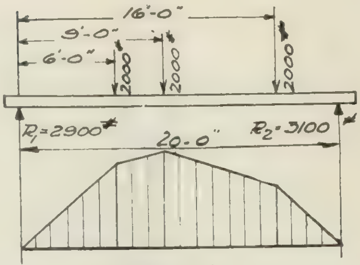


FIG. 4

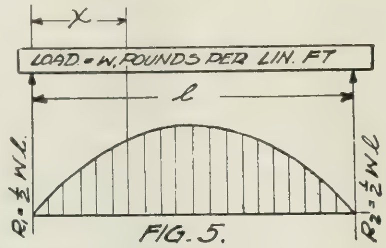


FIG. 5.

Figs. 4 and 5—Sketches Illustrating the Principle of Bending Moments as Applied to Simple Beams

The reactions due to both uniform and concentrated loads on a simple beam may also be computed in one operation. As an example, let there be a simple beam 24′ long between the supports and weighing 300 lbs. per lin. ft., its total weight being 7,200 lbs. (see Fig. 3). Let there be three loads of 1,200 lbs., 2,400 lbs. and 3,600 lbs. placed 6′, 10′ and 16′ respectively from the left support. To find the left reaction R_1, the center of moments is taken at the right support and the weight of the beam regarded as concentrated at its middle; then the equation of moments is $R_1 \times 24 - 7{,}200 \times 12 - 1{,}200 \times 18 - 2{,}400 \times 14 - 3{,}600 \times 8 = 0$, from which $R_1 = 7{,}100$ lbs. In like manner, to find R_2, the center of moments is taken at the left support, and then $-R_2 \times 24 + 7{,}200 \times 12 + 1{,}200 \times 6 + 2{,}400 \times 10 + 3{,}600 \times 16$, from which $R_2 = 7{,}300$ lbs. As a check the sum of R_1 and R_2 is found to be 14,400 lbs., which equals the weight of the beam and the three loads.

BENDING MOMENTS

The "bending moment" at any section of a beam is the algebraic sum of the moments of all the vertical forces on the left of that section. It is a measure of the tendency of these forces to cause rotation around that point. At the ends of a simple beam there are no bending moments, but at all other sections they exist, and the greater the bending moment the greater are the horizontal stresses in the beam, these stresses in fact being produced by the bending moment.

For example, let a beam 20′ long have three loads of 2,000 lbs. each, situated at distances of 6′, 9′ and 16′ from the left support (see Fig. 4). By the method explained above the left reaction R_1 is 2,900 lbs. and the right R_2 is 3,100 lbs. For a section 3′ from the left support the bending moment is $2{,}900 \times 3 = 8{,}700$ lbs.-ft., and for a section at 6′ from the left support the bending moment is $2{,}900 \times 5 = 14{,}500$ lbs.-ft. For a section 8′ from the left support there are two vertical forces on the left of the section, 2,900 lbs. acting up and 2,000 lbs. acting down, so that the bending moment is $2{,}900 \times 8 - 2{,}000 \times 2 = 19{,}200$ lbs. ft. For a section at the middle of the beam the bending moment is $2{,}900 \times 10 - 2{,}000 \times 4 - 2{,}000 \times 1 = 21{,}000$ lbs.-ft. For a section under the third load the bending moment is, in like manner, 12,400 lbs.-ft., and for a section at 2′ from the right support it is 6,200 lbs.-ft. The vertical ordinates underneath the beam in Fig. 4 represent the values of these bending moments, and the diagram thus formed shows how the bending moments vary throughout the length of the beam.

For a simple beam of span *l* and uniformly loaded with *w* lbs. per lin. unit, each reaction is $\frac{1}{2}\, wl$ (see Fig. 5). For any section distant x from the left support, the bending moment is $\frac{1}{2}wl \times x - wx \times \frac{1}{2}x$, where the lever-arm of the reaction is x and the lever-arm of the load wx is $\frac{1}{2}x$. If *w be* 900 lbs. per lin. ft. and *l* be 18′, the bending moment at any section is then $8{,}100x - 450x^2$, For $x = 6'$, the bending moment is 32,400 lbs.-ft.; for $x = 9'$ it is 36,450 lbs.-ft.; for $x = 12'$ it is 32,400 lbs.-ft., and so on. The diagram beneath the beam in Fig. 5 shows the distribution of moments throughout the beam, and it can be demonstrated that the curve joining the ends of the ordinates is the common parabola.

The bending moments for any section of a beam loaded both uniformly and with concentrated loads may be found in a similar manner.

The maximum bending moment indicates the point where the beam is under the greatest horizontal stresses and will usually be found near the middle of the beam and often under one of the concentrated loads.

Bending moments are positive for simple beams resting on two supports at their ends.

The same numerical values will be found for the bending moments when the vertical forces on the right of the section are considered.

Suggestions for Light Concrete Floor Construction in the Concrete House

By Milton Dana Morrill[1]

In a $600,000 residence lately put up on Long Island, N. Y., the builder, a man of progressive fibre, wishing to give a better construction then was called for by the plans, offered to put in a fireproof interior including reinforced concrete floors and partitions, at the comparatively small additional cost of $600.

The owner, however, did not appreciate the value of having his house fireproof, and did not accept the offer, and this fine house was built, as is the custom, with a mass of dry pitch-pine lumber put together like a tinder-box, only needing the smallest spark to start the blaze which in a few minutes' time could destroy not only the fine house with its priceless antique furnishings, but might prove a great hazard to the members of the family, who might be entombed therein.

This illustrates the fact that the public, as a rule, does not today realize in the smallest way the worth and value of proper construction, and "they know not what they build."

There may still be an excuse for frame construction in the cheapest and most temporary dwellings but if the home-owner realized the advantage and added protection offered his family through the use of a permanent fireproof type of building, progress would be much more rapid and safe and sane construction would be the universal order of the day.

Little by little headway is gained and masonry and fireproof walls are taking the place of frame, but sight is being lost of the most vital part of the house, the floor construction.

In several instances in concrete houses the entire frame interior has been gutted by fire, leaving the walls standing structurally uninjured and ready for rebuilding and re-use.

While this is a test which no other form of construction ordinarily outlives, and shows reinforced concrete as the superior wall construction, it also shows that only so far as a house is concrete is it fireproof, and it shows further that if concrete is good for walls it is still better and more valuable for floors and partitions. There its use will effectively block any general conflagration and confine any small fire to the floor or the apartment of its origin.

In houses a much lighter reinforced concrete construction can be employed than is used in other buildings. The architect or builder is likely to consider reinforced concrete from the masonry standpoint and is, therefore, inclined toward thick walls and heavy beamed floors. But counting inch for inch of structural section, reinforced concrete is a stronger building material than wood, and in the average house spans a reinforced slab 4″ thick is more than equivalent to the floor built up with 10-in. wood joists, and the 4-in. reinforced partition is far more substantial than the 6″ in thickness made up of studding, lath and plaster.

The ideal floor slab for light construction is of the flat or paneled type, with a light basket weave of wire, secured and supported on four sides, with just enough concrete for stiffening. The strength of such a slab is remarkable and far in excess of the tabulated strength generally credited to it. This was brough forcefully to the writer's attention during the construction of the 40 concrete houses in the Nanticoke[2] group, and in the tests there employed, and further in the eight concrete houses built near Montreal by the Canada Cement Co., where 4-in. slabs on 12-ft. spans were used, and wood sleepers, 1¾″ in depth were bedded in these slabs, giving a structural slab of only 2¼″ in thickness; yet these thin slabs were much more firm and substantial than are the usual wooden floors.

The average builder would hesitate to employ such construction and would question its stability. But the proof is there, where any one may see.

A suggestion is here given (see accompanying sketches) for a hollow paneled floor slab which might be used with considerable advantage in house building. It is intended to be constructed over inverted steel box forms, so shaped that they may be easily removed and used over and over again. The lightness and general substantial character of such a slab are apparent and need little comment or description. The sleepers are bedded in the members, 3′ o. c., forming the panels. Metal lath and plaster are to be applied on the under side of these panels.

Before any reinforced concrete work is commenced complete plans should be prepared, accompanied by specifications, stress computations, and descriptions showing the general arrangements and all details.

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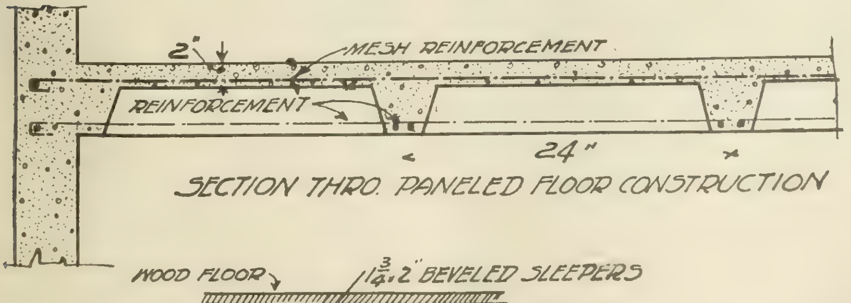
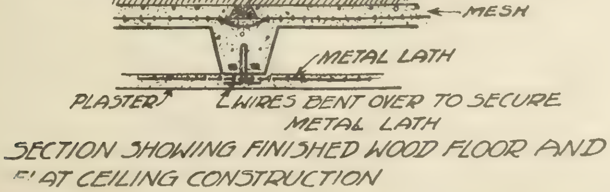
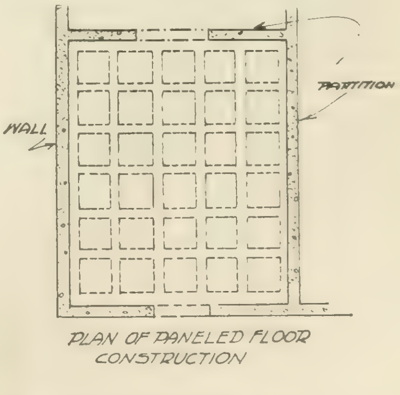
[1] Archt., Washington, D. C.

[2] See *Concrete*, Feb., 1912, p. 40, and Concrete-Cement Age, Apr., 1913, p. 173




WOOD FLOOR
1¾x2″ BEVELED SLEEPERS
MESH
METAL LATH
PLASTER
WIRES BENT OVER TO SECURE METAL LATH
SECTION SHOWING FINISHED WOOD FLOOR AND FLAT CEILING CONSTRUCTION



Detail of Panel Floor Construction for Low-Cost Houses

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Bonding Plaster Coating to Interior Walls and Ceilings

Discussed By C. W. J. Neville,[1] Emmet A. Steece[2] and W. M. Kinney[3]

"How should concrete surfaces, left by wooden forms, be treated so as to secure a good key for interior plaster on walls and ceilings?"

By Mr. Neville

Anyone who has carefully examined the under surface of a concrete slab after the forms have been removed and the concrete has thoroughly dried out, will probably have noticed a thin, loose coating of dried-out cement, ordinary dust and sometimes smoke, adhering to the slab. After having examined a number of cases of falling plaster, I have found in every case this film of dry dust between the plaster and the concrete, and have reached the conclusion that this and this alone is the cause of the failure.

Within the last 12 yrs., I have constructed concrete buildings, using both cinder and gravel concrete and have never had a single case of falling plaster. My instructions to the plaster foreman have invariably been as follows:

(1) See that the surface of the concrete is *absolutely clean.*. This ordinarily may be accomplished by washing with a hose but sometimes it will be necessary to use a weak solution and a brush.

(2) See that the surface is well dampened just before the plaster is applied.

(3) Use only two coats of plaster, a scratch coat and a finishing coat, and make these as thin as possible, the thinner the better.

(4) See that plenty of "elbow grease" is used in applying the plaster and that it is thoroughly pressed against the concrete surfaces while being applied.

By Mr. Steece

In the treatment of concrete surfaces in order to secure the adhesion of plaster or to provide a satisfactory plaster bond many methods have been used, experiments tried and failures met with. The proper method to use should not be resolved into a pride of opinion, for a failure means money thrown away.

I know of about six methods of concrete surface treatment, which will be described—not in the order of merit—as follows:

(1) Merely cleaning the surface of concrete as left by the forms with a stiff wire brush, washing with clean water and while still damp (not wet) applying the plaster.

(2) Washing the surface with a 25% solution of hydrochloric (muriatic) acid, then washing with clean water and finally brushing with a wire brush.

(3) Cleaning the surface with wire brush as in the first and the second method, then applying a liquid "plaster bond"—so-called—with an ordinary paint brush.

(4) Chipping or scoring the concrete with stone-cutter's tools.

(5) Lathing the concrete surface with metal lath. Eight-penny wire nails are driven into the form lining to a depth of about 1¼″ and 6″ apart each way. The nail points project from the surface when the forms are removed and the lath is simply laid on and the nail points clinched. In using this method it is sometimes desirable to provide a folded sheet metal washer or clip over the nail head to increase the holding power of the nail and to lessen the liability of pulling out when wrecking the forms, but if the head of the nail is above the plane of the reinforcing metal this is not always necessary. In this case the concrete needs no cleaning.

(6) Molded key, made by nailing long wood strips to the form linings. The strips to be ⅜″ thick by ¾″ wide, parallelogram-shaped section and spaced not over 6″ apart. The strips will draw out with linings when the forms are wrecked and a return beveled groove is made. This method gives satisfaction if properly executed and, with the exception of the usual cleaning, no other treatment is necessary.

From my personal experience and observation, I have arrived at the conclusion that the first method—if it can be so called—as described above will produce as good results as desired for plain plaster work, not exceeding ¾″ thick, particularly on ceilings. While I have known of tolerably heavy ornaments stuck on this class of ceiling work, ornamental work should receive special treatment. It must be borne in mind that the concrete surface must be clean and can be made so only by energetic use of the steel brush and water. If the forms—which will be referred to again—have been properly built the finish coat of plaster can be applied directly to the concrete surface. In such a case, however, the finish coat should not exceed ¼″ thick, although there are many instances where this thickness has been exceeded.

I will digress at this point to refer to plaster before proceeding further: As to which kind of plaster produces the best results, certain conditions may have influence, but common plaster and hydrated lime or lime putty, if properly applied, will give good results for the finish coat. In all probability the best results are obtained, however, in finish coat work, by the use of a good Keene's cement and lime mixed in the proportion of 5 parts of the former to 3 parts of the latter. But these proportions have been departed from greatly and still good results have been obtained. Under some conditions it is desirable to add a small amount of plaster but this can be left to the plasterer who has to do the work.

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[1] Gen. Contr., New Orleans

[2] Supt of Cons., Federal Bldgs., Chickasha, Okla.

[3] Engr. in Chg., Inf. and Insp. Bur., Universal Portland Cement Co., Chicago

The great advantage in the use of Keene's cement in finish work comes from the fact that this material can be retempered even after 24 hrs. without material deterioration; of course, it should be kept from setting hard, but ordinary intelligence would require that to be done. This property obviates, to a certain extent, the danger of applying dead material to a concrete surface, with inevitable failure. In fact, many cases of plaster falling from concrete ceilings can be charged to dead material.

Some plasterers prefer hard or patent plasters to Keene's cement and if properly handled these will give satisfactory results.

Returning to the main subject: The method of treatment No. 2 listed above gives satisfaction but the acid should be entirely removed before applying the plaster.

Method No. 3, the liquid plaster bond—so-styled—might be used, provided the owner of the building or the contractor who is responsible for the integrity of the work, gets a bona fide guarantee of worth from the manufacturer of the material.

Method No. 4 is hardly to be recommended on account of the expense due to the amount of labor required to do a satisfactory job.

Method No. 5 is excellent, though expensive. Heavy ornaments can be attached to this class of work without fear of failure if properly executed.

Good results will be obtained by following Method No. 6, about which further comment is unnecessary.

While not a treatment, in the strict sense, it might be well to suggest that when the concrete surface remains wet, due to the hygrometric condition of the atmosphere, and rapid changes of temperature, it is advisable to use about 5% or more of plaster with the brown mortar. This suggestion applies particularly to lime and sand mixtures and to combination mixtures of mortar in which Portland cement is incorporated. The plaster (plaster of Paris) accelerates the setting.

No reference to "Treatment of Concrete Surfaces" would be complete without touching the subject of concrete forms, especially the linings. Form linings should be made of matched stuff, not to exceed 5½" wide, with the rough, or undressed, surface in contact with the concrete. The narrow width is for structural reasons and the rough surface is to mold the concrete rough, thus performing the function of scoring as applied to the scratch coat of plaster work. It should be needless to state that the forms should be absolutely straight, for an uneven surface makes trouble for the plasterer.

By way of further comment, it may be pointed out that if the plasterer has much interest in the integrity of his work, and I am pleased to say that most of them have, a properly prepared concrete surface needs no nostrums to assist plaster to adhere to it.

By Mr. Kinney

To cause plaster to adhere firmly to concrete surfaces as left by wooden forms, the concrete should be roughened and thoroughly wetted before the plaster is applied.

If in filling the forms the workmen do not take the trouble to spade the coarse aggregate away from the interior forms, the surface will usually be rough enough to form a good key without subsequent roughening of the concrete surface. In any case the concrete should be thoroughly wetted before plaster is applied.

If the interior surface is smooth as a result of spading, so that the fine material of the mortar has been brought against the forms, the concrete should be roughened by the use of a stone pick or a bush-hammer. The bush-hammer is usually preferable in case the forms have been oiled, as it tends to break up the entire surface.

Where the builder desires to eliminate "sweating" resulting from condensation as a result of difference between inside and outside temperatures, nailing strips or wall plugs may be inserted while placing concrete; to these furring strips of wood or metal may be attached to provide an air space and to receive metal lath or wire mesh to which the plaster is applied.

Application of Sulphate of Zinc to Concrete, Preparatory to Painting

Discussed By Wm. M. Kinney[1]

"What quantity (weight) of sulphate of zinc per gallon of water should be used to make a wash to be applied to concrete block already in the structure preparatory to receiving a coat of paint?"

By Mr. Kinney

Under the title, "Methods of Painting Cement Surfaces," Edward Hurts Brown, in the *Cement World* of June 15, 1909, says, in writing of the zinc sulphate process:

> The method recommended by Charles F. MacNichol, a prominent painter of Washington, D. C., who has used it extensively on government and private work with uniformly successful results, is economical and has no injurious after effects on either the concrete or the paint, and moreover requires no after washing. He coats the concrete with a solution of zinc sulphate and water, mixed equal parts by weight, applying it with a bristle brush and allowing from 48 hrs. to 72 hrs. to dry. This causes a chemical change in the caustic lime, changing it to calcium sulphate (gypsum), and when the surface has thoroughly dried there will be a certain amount of zinc oxide in the pores of the concrete or upon the surface. This material being one of the most important of the white paint pigments naturally has no harmful effect upon any subsequent paint coats, but is incorporated with them by brushing.

Mr. MacNichol's process attracted so much attention that he was invited by the Am. Soc. for Test. Mat. to read a paper before that society June 30, 1910. This paper, entitled "The Painting of Cement and Concrete Structures," is incorporated in the Proceedings of the 30th Annual Meeting of the Am. Soc. for Test. Mat. Mr. MacNichol therein says:

> The method consists in treating the concrete surfaces with a solution of zinc sulphate and water, equal parts by weight, applied with an ordinary bristle brush after the concrete is dry. If the one precaution is observed of allowing from 48 hrs. to 72 hrs. as a drying period, this treatment will render a concrete wall as safe to paint as an ordinary plaster wall.

Mr. MacNichol states that he is not a chemist but a master painter. Therefore, desiring to know the chemical action which made the application of zinc sulphate so effective, he wrote to Dr. Allerton S. Cushman, then Chemist in Charge of Physical and Chemical Investigations, Office of Public Roads, Washington, D. C., propounding the question: "What chemical action takes place on a concrete surface when a solution of zinc sulphate has been applied?" In reply to this question Dr. Cushman said:

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[1] Engr. in Chg., Inf., and Insp. Bur., Universal Portland Cement Co., Chicago

> In regard to the scheme for painting concrete work with a solution of zinc sulphate in order to make the surface hold a paint coating, it is my belief that zinc sulphate is very well adapted for this purpose, owing to the fact that when zinc sulphate is brought into contact with calcium hydroxide (hydrated lime), a chemical reaction takes place which results in the formation of calcium sulphate (gypsum) and zinc hydroxide (hydrated oxide of zinc).
>
> It is apparent from this that after the surface has become thoroughly dry again it will contain within its pores a mixture of gypsum and zinc oxide; these materials have no bad influence on linseed oil and, in fact, are frequently used as paint pigments.
>
> The reason why some such treatment should be necessary before applying a paint coating to the surface of concrete must be apparent to everyone. When Portland cement sets, a certain amount of lime is set free in a hydrated condition as calcium hydroxide. This is a strong alkali, and tends to saponify the oil in the paint coating and thus destroy it. The work done by the application of zinc sulphate is to destroy this alkalinity, and change the calcium hydroxide into a mixture of calcium sulphate and zinc oxide.

Engineering & Contracting for Mar. 20, 1912, contains an article by Jerome Cochran, entitled "Inspection of Surface Finishes for Concrete Work." Under the heading, "Painted Surfaces," Mr. Cochran says:

> Concrete surfaces may be treated with a solution of zinc sulphate and water, mixed equal parts by weight, and applied with an ordinary bristle brush after the concrete is dry. The concrete should be at least 48 hrs. old, preferably 72 hrs., before applying the zinc sulphate solution.

CONCRETE-CEMENT AGE for May, 1913, publishes on page 241 the following letter from Andre L. Casset, 15 Avenue d'Allemagne, Paris, France:

> I believe that your readers would be glad to know a simple and effective process of painting over concrete surfaces. The reason that oil paint does not stand well on concrete surfaces is that the oil is saponified by the free lime of the cement. We have found it good practice to put on a coat of cheap metallic sulphate solution, say zinc sulphate, about a 1:5 solution. This produces, by the following reaction, a coat of plaster and zinc sulphate quite harmless to oil over the concrete surface. ($CaO + SO_4 Zn = CaSO_4 + ZnO$).

The *National Builder* for Aug., 1914, contains an article by R. H. Langston, from the *Master Painter*, entitled "Painting over Cement." This article says:

> It must be understood that ordinary linseed oil paint cannot be applied with success directly to cement or concrete surfaces, on account of the alkaline lime present in the cement, which is subject to prolonged formation in the presence of moisture. The action of this alkali is to burn up or destroy the oil, causing rapid fading of colored paint, chalking and scaling off of the material. Therefore it is necessary, if a linseed oil paint is to be used, that the surface be first thoroughly saturated with a neutralizing wash that will destroy the alkali action. The most approved method is to use a solution of zinc sulphate made by dissolving sulphate of zinc crystals in water in the proportion of 3 lbs. per gal. of water. A cement surface treated with this wash and allowed to dry can then be painted without danger from alkaline action and with the assurance that the result will be as lasting as if applied to a wood surface. Many manufacturers now put out cement paints in liquid form, ready for use, in white and all shades, the vehicle used in these paints being alkali-proof and therefore requiring no treatment of the surface before the paint is applied. Paints of this nature are being used extensively on cement and concrete construction with the very best results and can be obtained at a very reasonable price.

In the *Architect and Engineer*, for Oct., 1914, there is an extract from a paper on paint protection for Portland cement surfaces, by H. A. Gardner, Washington, D. C., which was read recently before the Am. Soc. for Test. Mat. In this article Mr. Gardner says that a priming coat of 25% zinc sulphate solution was applied to concrete to neutralize any free lime, but it is held that this is unnecessary if the surface is dry when painted and is not to be exposed to the weather. Tests conducted showed that the amount of free lime in thoroughly dry cement surfaces does not adversely affect high-grade oil paints. They also showed that zinc sulphate may be used with excellent results as a primer to neutralize free lime in cement surfaces which are to be painted. Reference to this article will show the classes of paints which were tested in reaching the determinations recounted in Mr. Gardner's paper.

The various authorities upon the quantity of sulphate of zinc are therefore found to be as follows:

(1) Charles MacNichol: "A solution of zinc sulphate and water, equal parts by weight."

(2) Jerome Cochran: "A solution of zinc sulphate and water, mixed equal parts by weight."

(3) Andre L. Casset: "Zinc sulphate in about a 1:5 solution."

(4) R. H. Langston: "A solution of zinc sulphate made by dissolving sulphate of zinc crystals in water in the proportion of 3 lbs. per gal. of water."

(5) H. A. Gardner: "Twenty-five % zinc sulphate solution."

Design of an Anti-Freezing Water Filter □ □ □

DISCUSSED BY WM. M. KINNEY[1]

> *"How would you design an anti-freezing water filter, which is to be built in the ground between a cistern and the down-spout of a house, using gravel and charcoal as a filtering medium? The ground between the house and the cistern is level and the cistern is of 200 bbl. capacity."*

BY MR. KINNEY

The accompanying illustration shows a modified design of a water filter being adapted in part from the *Cement World* for June 15, 1911. The original design shows the filter below ground, which does not result in complete drainage of the filter or use being made of the entire capacity of the cistern.

There are likely to be two objection made to the modified design. First is the danger of accident to the filter erected above ground, though this could be overcome by erecting it close to or against the side of the house.

The second objection would be the exposure of the filter to freezing. However, the drainage of an elevated filter could easily be made so perfect that the only water passing through the filter when the temperature is below freezing would be a relatively small volume, from snow melting on the roof, so that this objection would not appear to be serious unless the filter were located in a very exposed position on the north side of the house.

The illustration shows the design in cross-section only, in order that it might be used within reasonable limits for cisterns of different capacities. The mean dimensions are as-

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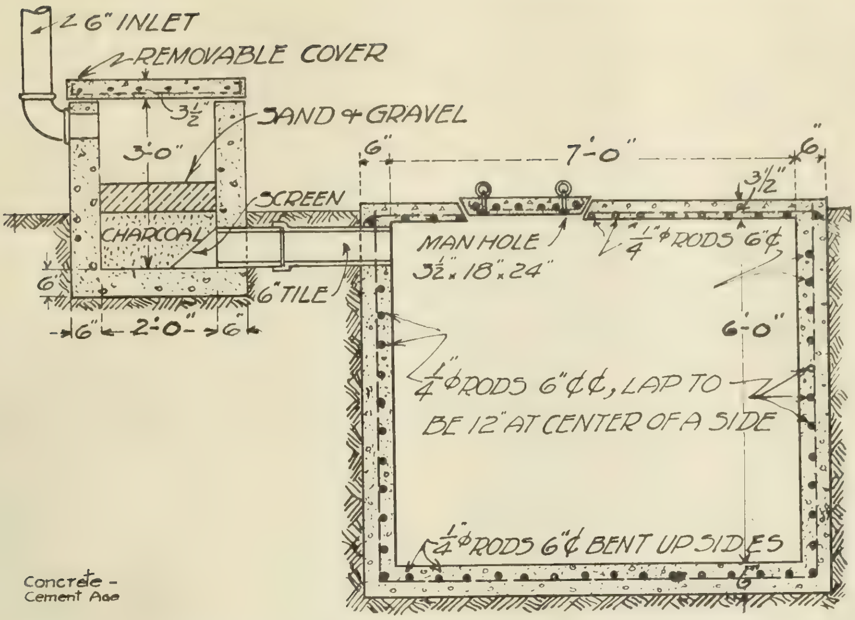
[1] Engr. in Chg., Inf. and Insp. Bur., Universal Portland Cement Co., Chicago



Design of Anti-Freezing Water Filter

sumed to be 8′ x 8′ outside dimensions, with a total height of 6′ 9½″; walls, 6″ thick; concrete bottom, 6″; concrete cover, 3½″, giving a capacity of 70 bbls.

The rods that reinforce the floor and are bent up into the wall should be ¼″ in diam, and 20′ 6″ long, bent to a right angle 6′ 6″ from each end. The center of this U-shaped rod acts as the size of filter is determined by the base and the legs act as vertical reinforcing for the walls.

Under most conditions a filter 2′ x 2′ and 3′ deep will be large enough as the size of filter is determined by the intake rather than by the cistern capacity.

Mixture of Mortar for Laying up Block Walls

Discussed By R. F. Havlik,[1] A. E. Cline[2] and H. P. Warner[3]

"Occasional cracking in concrete block walls, chiefly at the mortar joints, is something which I should like very much to avoid in the construction of a rather large house which I am about to erect. It has been suggested to me that instead of a Portland cement mortar, I use a mixture of 1 bbl. of lime to 1 sack of cement with twice the bulk of good sharp sand. What do you think of such a suggestion? If the suggestion isn't a good one, what mixture do you suggest, and what other things should be considered in laying up a block wall to avoid cracks, besides, of course, the stability of the foundations?"

By Mr. Havlik

There are three possible causes for cracks in the mortar joints of concrete block walls, none of which, however, can be attributed directly to the mortar. The first and most probable one is that the footings are too narrow for the superimposed loads and allow the building to settle unevenly. This will always cause cracks either through the blocks or through the joints, as they are the weakest points of the wall. A second cause, and quite a common one, is that the block are not cured sufficiently before being laid in the wall. In this case they will shrink and often open the joints. A third cause is striking the joints as soon as the block have been laid. The mortar, being very soft, tends to settle and in so doing separates from the block, causing a crack. Such cracks may be at the exposed surface only and may not extend through the wall. In all the work at Mooseheart we use a mortar of ⅓ part hydrated lime, 1 part of cement and 2 parts sand, all measured loose. This is just enough of lime to make the mortar work smoothly and to keep it from drying out too rapidly. We make all our joints concave with a half-round tool and do not strike the mortar joints until they have partially set. Thus far we have had no joints open. Too much lime makes a soft, crumbly mortar, and 1 bbl. of lime per sack of cement will prove very unsatisfactory.

By Mr. Cline

In my experience the best mortar for laying up block walls is a good lime mortar, 1 part well slaked lime and 3 parts of clean sharp sand, to which is added ⅓ part, by bulk, Portland cement as the mortar is used. This is much stronger than the plain lime mortar, yet it works smoothly under the trowel and gives the wall time to settle into place before getting too hard. An all-cement mortar is harder to handle and sets up too quickly for the best work.

I have used with good success a mortar made of 1 part hydrated lime, 1 part Portland cement and 3 parts sharp sand. This is very handy to use on small jobs, such as house foundations.

By Mr. Warner

I can see no objection to the use of a cement mortar. In fact, my experience has shown it to be preferable to lime mortar in concrete block walls, a small amount of lime being added to make the mortar work better.

The suggested mixture, 1 bbl. of lime to 1 sack of cement with twice the bulk of sand, I believe too rich in lime, and would suggest about ¼ of the amount of lime to a sack of cement and 3:1 or 3½:1 mixture.

An important feature, and one very often overlooked or ignored in laying concrete block, is a thorough wetting of the surfaces which come in contact with the mortar. I believe that this procedure is fully as important and necessary to a satisfactory job as the quality of mortar used. If this wetting is carefully and thoroughly done and caution is used in completely filling out the joints, which should be at least ⅜″ and preferably ½″, with a mixture as outlined above, I believe there will be no difficulty experienced with cracks, assuming, of course, that the foundations are properly constructed.

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[1] Engr. in charge of construction, Mooseheart, Ill.

[2] Peekskill Stone Co., Peekskill, N. Y.

[3] Pres., Onondaga Litholite Co., Syracuse, N. Y.

Renewing a Basement Floor □ □

Discussed By L. C. Wason[1] and A. Morgan Smith[2]

"A new concrete floor in a residence basement, which is approximately 50' by 20', is required. The old floor is wavy, rather rough and is crumbling in some places. The matter of headroom in the basement would not seriously interfere with laying a new floor on top of the old floor, providing it did not have to be more than 2" thick, yet it would be preferable to lay less concrete than would be required by 2", if it can be done with satisfaction. Should the new floor be laid on the old floor, and if so, what is the proper procedure and what will be the best aggregate and mixture to use?"

By Mr. Wason

A 2-in. pavement would not bond with the old floor. If it is uneven and 2" is planned as the minimum thickness, it might average 3", and a 3-in. pavement is the minimum thickness that ought to be used for a durable cellar floor. It would probably cost $20 to $25 more than a 2-in. floor, which would not be satisfactory. If more headroom is necessary by all means take out the old floor and excavate the earth.

By Mr. Smith

Few places are so ideal for concrete to set up slowly, insuring a hard body and surface, as in a cool place like a cellar, yet it is a lamentable fact that this part of the house construction is nearly always slighted from start to finish.

In several cases I have found the concrete cellar floor to be merely a "bluff"; a very poor bed would be about 1" of dirty weak concrete and a lather of finish only to even over the roughness.

To repair a cheap cellar floor is a waste of money and for a troublesome floor of this kind, my advice would be to use a sledge or pick, using part of the old floor for a bed for a real concrete floor which is 3" of 1:3:6 concrete and a 1:2 finish not less than ¾" thick. The manner of repairing a good hard concrete floor is one that requires experience and patience. If you tell the average "Hunkie" how it is to be done, very likely when you come back you will find time and material wasted.

Patching a rough place or hole in the finish of a hard and solid concrete floor can be done as follows: Chip away at least ¼" all over the place to be repaired and keep as wet as possible for at least 10 hrs.; mix enough finish for the job of 1 part cement and 1½ parts crushed stone dust or fine sand (thoroughly mixed). Apply what will make about ¼" layer (sloppy) and rub well in with whisk broom or coarse brush to insure good contact for bonding; then even up with balance of finish. Over the finish keep a wet cloth for a few days. To obtain a uniform texture between the patch and the balance of the floor, rub with a carborundum stone.

Fire-Resisting Qualities of Concrete

Discussed By W. M. Kinney[1]

"What security does reinforced concrete construction offer against fire loss?

"Is any vital element of the structure exposed to injury in case of fire, and

"What injuries have resulted from fires in reinforced concrete buildings?"

By Mr. Kinney

Experimental tests made by Prof. Norton, Prof. Woolson and others conclusively establish the fact that concrete will protect either structural steel or reinforcement from damage in case of fire. The most unanswerable argument for reinforced concrete as a fire-resisting material is found in the numerous examples of structures which have successfully withstood extraordinary exposure both to exterior and to interior fires.

In properly designed reinforced concrete structures no vital element of the building is exposed to injury in case of fire. Where the temperature ranges from 1,600° to 2,000° F. concrete is usually dehydrated to a depth of ½" to ¾". But this increases the heat resistance so that the process of dehydrating is very much retarded and the body of the concrete is unaffected; consequently loss is ordinarily limited to negligible spalling at corners or other severely exposed portions.

The most recent example of the behavior of reinforced concrete in a severe fire is shown by the storage warehouse of the Naumkeag Cotton Co., Salem, Mass., which was the only building that went unharmed through the great fire of June 25, 1914. This building is of reinforced concrete throughout, and not only saved contents valued at $200,000, but came through the fire practically uninjured, except for cracking and melting of wire glass in windows, showing the extreme heat to which the building was subjected. Full details of the building and the Salem conflagration are given on pages 45 and 61 of Concrete-Cement Age for Aug., 1914.

How reinforced concrete will stand exposure to an interior fire is exemplified by the glue factory of F. W. Tunnell & Co., Philadelphia, which was subjected to a severe exterior and interior fire on June 24, 1909, reported in Cement Age for Aug., 1909, from which we take the following facts:

The building is a three-story structure and is of reinforced concrete throughout. Walls are 12" thick. When the fire was in full blast the concrete structure was practically enveloped in flames. Wooden drying racks in the concrete building took fire, and soon there was a mass of flames within and without. A brick boiler house adjoining the concrete building was so badly damaged that it was necessary to take down the walls. One end of the reinforced concrete building was open, and through this the flames concentrated upon a concrete column which merely spalled. The vital parts of the structure remained intact, and the building is practically uninjured, except that a wire-lath and plaster ceiling suspended from the roof beams was destroyed by the intense heat, and the wire glass in open windows melted, hanging like sacks from the metal sash.

Automatic sprinkling systems should be encouraged in the construction of all reinforced concrete buildings, for the protection of the building contents. When the structure is of reinforced concrete and the contents are protected by automatic sprinklers, the insurance hazard is reduced to an almost negligible risk—even the water damage being localized. On the other hand, the advantage of concrete's fire resistance may be largely lost by neglecting to provide automatic sprinklers in a building filled with inflammable merchandise, office furniture or wood partitions, in any of which fire develops with great rapidity, destroying the contents and making subsequent repairs to the building necessary.

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[1] Pres. & Mgr., Aberthaw Constr. Co., Boston

[2] Architect, Mt. Lebanon, Pa.

[1] Engr. in Chg., Inspection Bur., Universal Portland Cement Co., Chicago

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Concrete Floors in Dwelling Houses

A Letter From Homer Laughlin, Jr.[1]

To give you accurately my experience in living in a house with concrete floors, it will perhaps be well to go back a little way and relate my experiences which led to the adoption of a concrete floor for a residence.

The Homer Laughlin building, which I own, was built in 1898 and was the fifth building in the U. S. and the first building west of Chicago to use concrete floors. These were concrete floors placed on a steel skeleton. At the time the building was opened I had grave doubts of its success because every prospective tenant brought up the subject of the floors. Either they themselves were affected by rheumatism or they had some one in their office who had rheumatism and they were quite sure that living in an office with concrete floors would be detrimental to their health. The common remark was that they could feel the chill of the concrete go through them the moment their shoes touched the floor. Although the prejudice was gradually overcome it was at least five years, when concrete floors in office buildings had become more general, before the attention of the public was attracted to other features and away from the concrete floors and I may safely say that it has been at least three years since I have heard a single person mention the subject[2].

When I was about to erect my home and decide on the subject of floors, my father, who had been a strong advocate of concrete floors in office buildings, advised me against their use in a residence. Careful inquiry developed that he himself was not opposed to the floors but was satisfied that my friends and others would interpose all the objections to their use in a residence that we had formerly gone through in our office building and so I decided to put wooden floors downstairs for the benefit of my friends and concrete floors upstairs for the use of my family; but finally we worked up one excuse after another for leaving the wood floors out of certain downstairs rooms and finally they were left out altogether.

My floors are of a warm brown tone and come up on the side walls about 6″ and flush with the plaster to form what would otherwise be a baseboard. Downstairs they are decorated with a pallette-knife and look somewhat like carved leather. After the "carving" had been done an artist worked various colors of the rainbow into the decoration and then they were all varnished and waxed so that keeping them in order is similar to the polishing of wood floors but the polishing is required much less frequently.

Upstairs we use velvet carpets of double width and plain colors, sewed together to form a mat or rug, but without a border, and extending within 6″ or 8″ of the side walls all the way around. We find that no nailing strips or other means of fastening are necessary, since the carpet lies perfectly flat and is sufficiently large so that it will not move about.

Downstairs we use Oriental rugs entirely and a curious feature in this respect is that moths will not hatch on the under side of a rug in contact with concrete, where they do hatch when it is in contact with wood. This applies to the under side of the rug only, because it is not impossible for them to hatch within the rug fabric itself.

Now, the common impression is that a concrete floor will make the room cold but this impression is reached by people who have gone into rooms with concrete floors where there was no carpet on the floor and because at the moment, they were critical of concrete, but if one will go into a bare room where hard wood floors have been used they will get exactly the same effect. The addition of carpets and tapestries decreases the number of square feet where the air of the room comes in contact directly with the floor or side walls.

There is also an impression that concrete floors are damp. They are damp for the first two months after being laid and on this account should not be varnished or waxed, but after this period they are as dry as wooden floors. I have made accurate tests with hygrometers, to determine this point.

The concrete floor is to me most satisfactory because it is free from cracks in which dust accumulates and ascends every time the floor is flexed by stepping on it. There is never a squeak or other noise produced by the rubbing of one board of the interior floor on another. With carpets on the floors they are absolutely noiseless, and one cannot detect a person walking on an upper floor when he is in the room below, provided of course that there is a carpet on the floor above.

The concrete floor makes a much handsomer setting and background for Oriental rugs than wooden floors and one can do away with the unsightly baseboard, which always collects dust. Then there is none of the trouble of warping and straining which comes with the use of wooden floors.

Above all else the house is fireproof when properly built in other respects and one can leave home with the assurance that neither property of any considerable value nor lives will be destroyed in the event of fire. I feel that my pictures, rugs and porcelains are as safe in my house as in a vault at the bank, barring the possibility of theft, which is rather remote[3].

Business Opportunity in Australia

A Letter From Edwin C. Elliott[1]

There has never been so favorable an opening for U. S. manufacturers to secure Australian business in quite a large number of staple lines, but they must beware of greedily advancing prices or permitting the opportunity to be stultified by freight rings.

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[1] Los Angeles, Cal.

[2] We use concrete floors in our offices. No rheumatism reported—Editors

[3] Happy California!—Editors

[1] Sydney, Australia

Co-operation in Small Building Development

A LETTER FROM P. H. BOSWORTH[1]

I should like to know what is thought of the idea of attempting to get the cement manufacturers together in a national organization to experiment in small building construction? Cement is established in engineering and large building works, but in small buildings under $10,000 practically no definite headway has yet been made; no permanent results have been accomplished.

One principal reason for this is that there has been no systematic action or team-work among the inventors or designers. Each has tried to evolve a completed system of his own, without infringing on his competitor. This is a practical impossibility; it merely means tying up the entire industry with a lot of useless patents out of which no one will make any money during the life of these patents and it will end by putting the business back 20 years or more and the original inventor will be dead and gone before his idea is even put into practical operation.

It takes years of steady work improving each operation to perfect such a thing as the erection of a concrete building.

Take the larger concrete building work in San Francisco. We are doing quite a lot of it and the proportion of concrete buildings is getting larger every year. Today we can put up a concrete frame, outside walls, floors, columns, and girders for just about one-half what the same work could be done for after the fire, when the industry started here. A concrete frame "Class B" construction costs today between $15 and $16 per cu. yd. of concrete complete; forms, reinforcing, pouring and stripping, that is for 6-in. walls, 4-in. slabs, 16-in. x 18-in. girders, 10-in. x 12-in. columns. After the fire some buildings cost as high as $1.50 per cu. ft. of concrete complete, about $40 per cu. yd.

This reduction in cost has been made possible by the fact that there have been no patents to hinder the complete interchange among the builders of ideas and methods of operating. Each little improvement has been taken advantage of by every builder, to the advantage of the entire industry; everybody has gained, both the contractors and the property owners, and the buildings are much better constructed and erected in less time.

I have a couple of patents on forms and a hollow wall construction. I would gladly release my patent rights if some national organization working with all other patentees would roll all our ideas and patents into one or two comprehensive methods of small building construction, that could be pushed throughout the U. S.

We, as patentees, would make more money by taking hold of this composite building even though anybody else could do the same, than we are making today by our "dog in the manger" policy of lying down and covering up what we can't use ourselves.

It is logical to suppose that the sum of all the ideas that have been advanced by the different patentees used to the best advantage is far better than any individual set of ideas and methods; and furthermore, it will be more profitable to the patentee to release his patents and get a business that is sure to be very profitable than to keep some useless patents until they and he expire. The cement companies could back such a national organization as this for promotion purposes. They are spending much money today for printers' ink, trying to help small building, but to no such purpose as this plan I propose. They can work both selfishly and unselfishly in putting through such a scheme; their great profit would come in the greatly increased use of cement.

This plan of mine is merely broad-minded co-operation; co-operating to do collectively what we cannot do individually and even if we could get ahead individually we could not get ahead so fast nor so well.

In financing this plan, the cement companies would not really have to spend any money in the sense of not getting it back again. All the money advanced for this proposition would eventually come back surely in cash with interest and a profit attached. It takes money to buy land and erect buildings, but, properly located and built, the finished proposition is worth more than it cost to build and is readily salable.

A plan of this character carried out would redound to the benefit of the inventor or designer, the concrete industry, the cement industry and the economic conditions of the country at large.

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[1] Archt. and builder, San Francisco, Cal.

All ordinary bar bending should be done cold. It is very important, especially in bending large bars, that the bending force be applied gradually and evenly and not with a jerk.

Concrete Floors for Stables

A LETTER FROM LEONARD C. WASON[1]

A proposed regulation requiring the use of concrete floors in all new stables or stables which are partly rebuilt in the City of Hartford, Conn., was objected to by numerous owners of fine horses on the ground that the concrete floors are injurious to horses. It should be understood that a concrete floor for a stable consists of a concrete base with granolithic finish laid similar to a sidewalk, but grooved into 6-in. squares to prevent slipping. The question was asked of the Aberthaw Construction Co., Boston, whether or not the objection was well taken.

In order to answer this question intelligently, we sent letters to 15 stable owners for whom we have built concrete floors. All of these floors were laid previous to 1907, the majority dating back to 1895, '96, '97 and '98. In these letters we asked the following questions regarding the floor:

First—Is it injurious to horses?

Second—Has it proved to wear satisfactorily?

Third—If you had another stable to build, with your present experience, would you again use concrete?

All of the answers, but one, were very favorable to concrete floors. The one exception was from a stable owner who, through seldom visiting his stable, had not formed a definite opinion. A visit to this stable, however, revealed the fact that the hostlers were very favorable to the floors.

In addition to these letters, we examined nearly all the above floors and many others of different kinds laid by various people.

Taking up the first question—"Is it injurious to horses?"

The owners of stables practically unanimously agree that concrete is not injurious to horses. It is not too slippery and may be kept very clean. The hostlers, however, seem divided in their opinion. About half of those approach claimed the floor was slippery. On carefully questioning them, however, it developed that the horses would not actually fall down, only slipping until their shoes caught in the grooves. Many of the hostlers claimed that the concrete was gritty enough to prevent much slipping, even without the grooves. All seem agreed that wood should be laid over the concrete in the stalls, to keep the horses from having to stand or sleep directly on the cold surface.

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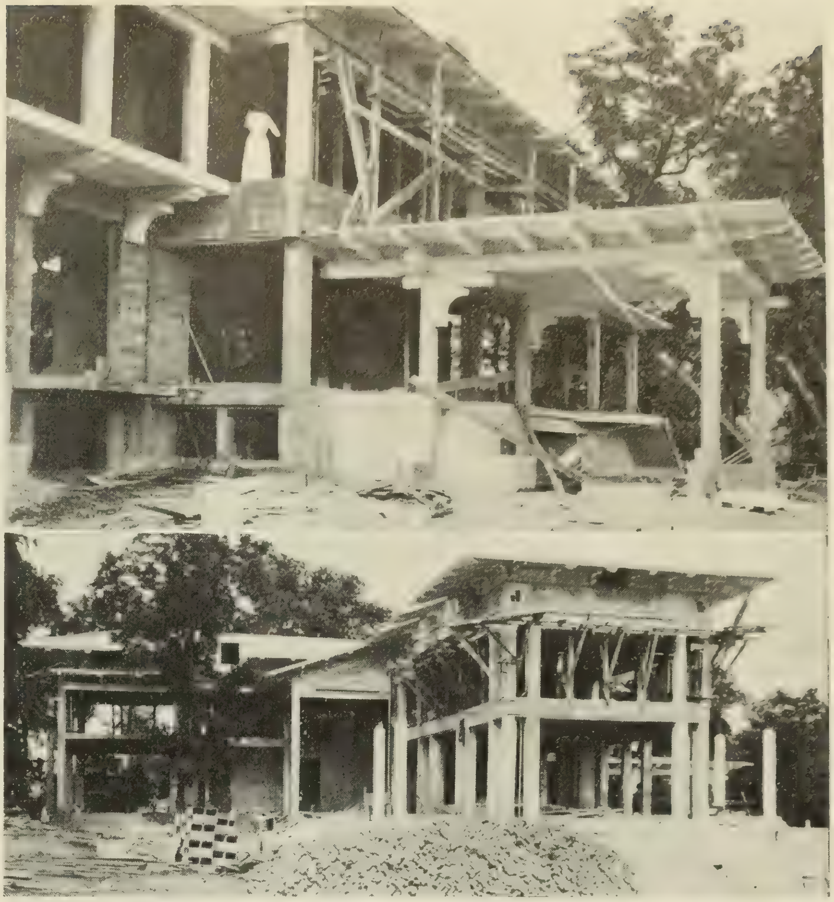
[1] Pres., Aberthaw Constr. Co., Boston

"Has it proved to wear satisfactorily?"

We could find no objections whatever on this score. Concrete drains from the stalls, after 18 yrs. of service, seemed only slightly affected by uric acid from the horses. All owners approached, with one exception, were quite emphatic that they would again use concrete if they had another floor to lay. The one exception was in doubt.

In the course of this inquiry it developed that asphalt floors are too dead, and do not wear particularly well. Wooden floors are hard to keep clean, do not wear well, and are sometimes quite slippery. Several hostlers were found who felt that the slippery condition of concrete floors could be best eliminated by using paving stones, grouted in with cement. This floor, however, is not so easily cleaned, and is more expensive.

The proposed regulation would not impose a hardship on stable owners, for concrete is cheaper than asphalt, vitrified brick, or paving stone grouted in with cement.



Figs. 1 and 2—Structural Features of a Reinforced Concrete Residence at Kansas City, Mo., Showing 6-ft. Overhanging Roof and 60-ft. Beams

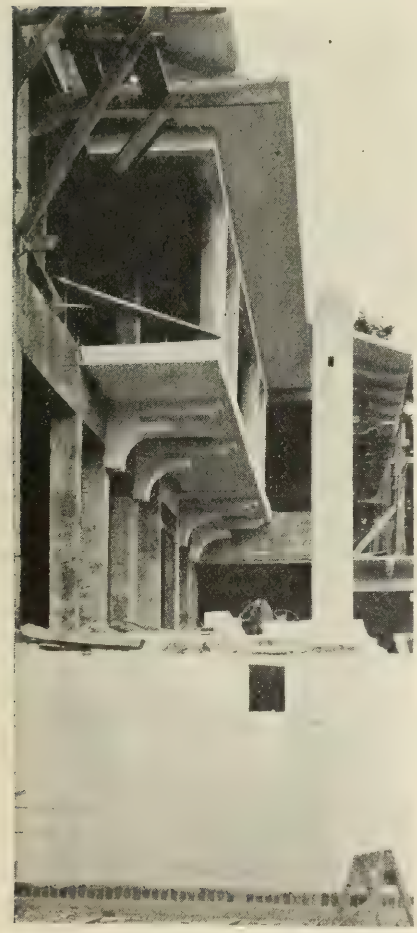


Fig. 3—Detail of Bracketed Balcony of Reinforced Concrete

Structural Features of a Reinforced Concrete House

The accompanying illustrations show several interesting features in connection with a reinforced concrete residence recently constructed in Kansas City, Mo., costing about $125,000, among them being the 6-ft. overhanging concrete roof, covered with tile, and 60-ft. reinforced concrete beams used in constructing the east wing. Louis Curtiss is the architect. The house was built for the estate of Bernard Corrigan.

The house has a reinforced concrete frame with a veneer of stone or Phoenix marble capable of taking a high marble polish when used in the interior. It is planned in the shape of the letter "L" with each wing about 30′ wide, the wing to the east extending 120′ from the northwest corner of the "L," the other wing extending south about 100′ from that corner. The arrangement makes for coolness and allows the owner to look out upon his own house. Aside from halls, this house has a thickness just of a single room, departing from the general arrangement that places a row of rooms on either side of a center hall. The interior is structural rather than decorative; that is, it has been sought to make the construction beautiful in itself, eliminating the necessity for ornamentation.

The concrete framework presents no divergence from standard practice. The floors are of hollow tile and joist construction. The concrete roof slab is covered with heavy asphaltic paper and then covered with tile.

A dry mixture is unfit for use in rubble concrete or concrete rubble, because it will not flow around the large stones and coat them with cement.

When the aggregate is composed of both broken stone and gravel, they should be mixed in such proportions as will give the least percent of voids when mixed.

Methods of constructing concrete sidewalks must be employed which will avoid settlement cracks, upheaval by frost, crumbling due to work done in freezing weather, contraction and expansion cracks, separation of top from base, and disintegration.

Concrete Block House, With Double Wall, Which Cost Less Than $2,500

The 7-room concrete block house shown in the accompanying illustration and in detail in the drawing was erected at Lake Geneva, Wis., by the Cement Stone & Brick Mfrs., for approximately $2,500, including plumbing and hot water heating system and also including profits. A distinctive feature of the house is the large wall unit, using 12-in. high block.

All of the walls are of double construction with an air space. The basement walls are 5″ thick on the outside and 5″ thick on the inside, with a 2-in. air space. Above the basement level the walls are of 5-in. block on the inside and 4 -in. block on the outside, also with a 2-in. air space. The block in the basement walls, both sides, are 8″ high and 24″ long, and the block forming the inner wall above grade are also 8″ high, while those on the outside are 12″ high and 24″ long. All the block were made on a Hobbs[1] machine. Plain block were, of course, used below grade, and rock face granite block were used in the exposed portion of the foundation up to the water table. Panel face granite block were used over the water table to the second story height, with stucco on plain block from there to the roof. The porch columns, baluster work and other ornamental pieces

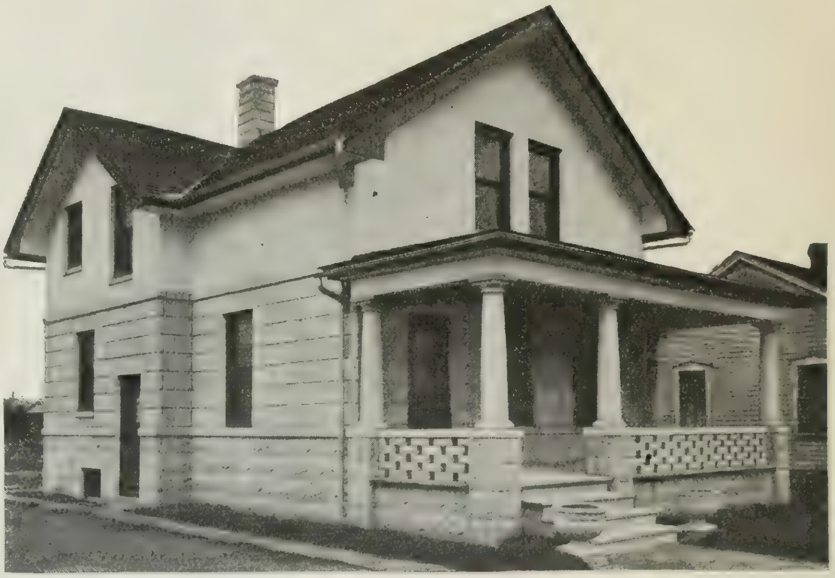


Fig. 1—Concrete Block, Double Wall House, Costing $2,500

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[1] Hobbs Concrete Machinery Co., Detroit

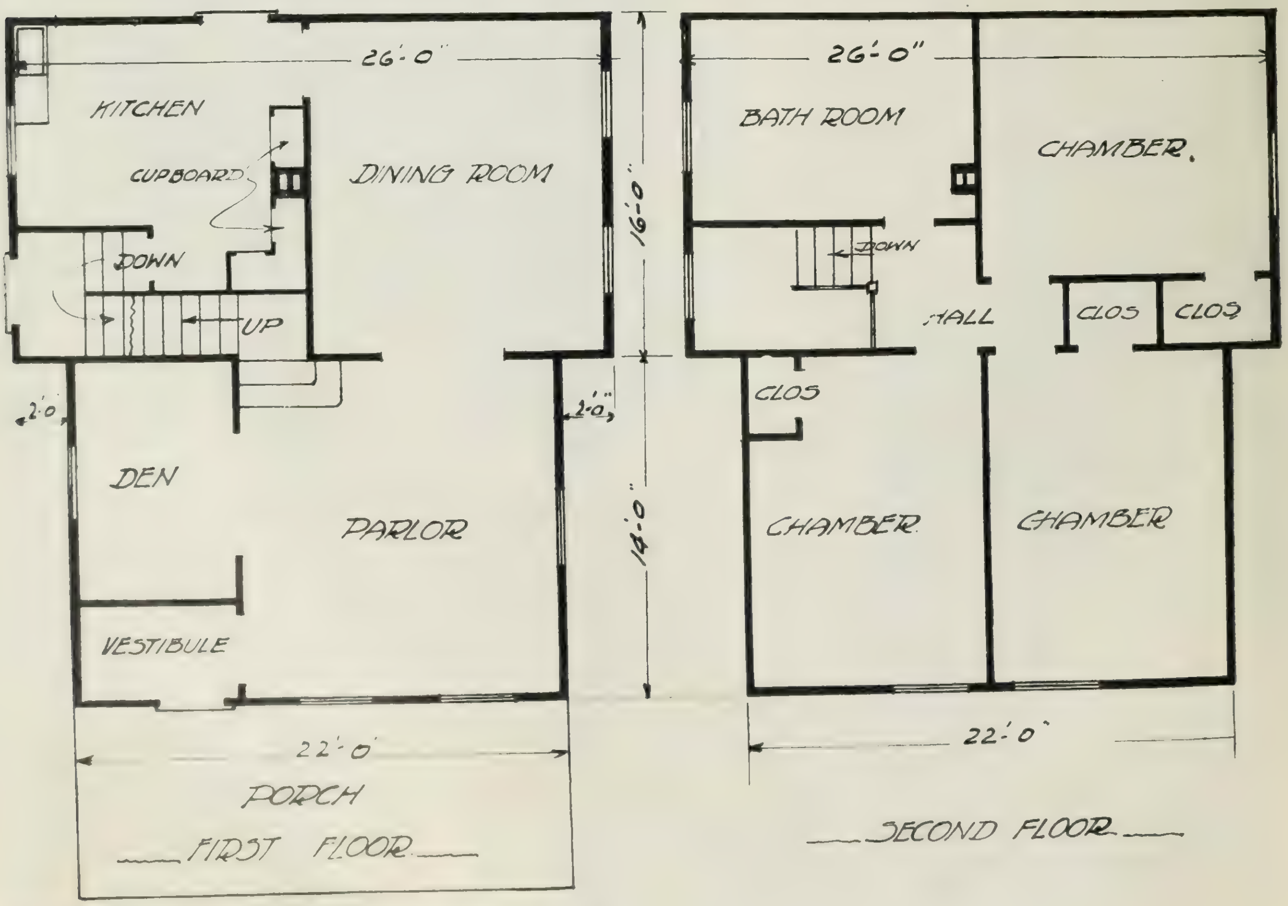

Fig. 2—Floor Plans Concrete Block House Costing $2,500

were made in Simpson[2] molds.

In laying up the walls, wall ties were used with ¼-in. round material bent at each end. Manufacturers, in figuring the cost of the materials and labor a profit of 30%, this covering the manufacturing end only of the concrete work. The units required are listed as follows at the retail price:

940 solid stone, 5" x 8" x 24"	$103.40
1,500 solid stone, 4" x 8" 24"	150.00
218 solid stone, 4" x 12" x 24", using a facing of granite and white cement	54.50
332 solid stone, 4" x 12" x 24", granite face	83.00
10 window sills and caps, 3' 8" long, 4" thick, 12" high	15.00
15 window sills	13.50
80 pier stone, 4" x 12" x 12", granite face	12.00
5 porch columns	30.00
28 chimney block, 4" x 8" x 20"	5.04
80 baluster block, 4" x 4" x 12", rock face, two sides	8.00
202 lin. ft. water table, 5" thick, 6" high	50.50
25 lin. ft. hand rail	3.60
	$528.64

This gives a total of $528.54.

The excavation cost $40.00.

The mason work is itemized as follows:

Mason and laborers at $5.00 and $2.25 per da. of 8 hrs. respectively, laying block	$210.00
Pointing walls	30.00
Sand, cement and lime for laying block	28.00
	$268.00

This gives a total, including mason work, materials and labor, of $796.54.

Rough lumber and mill work cost $565.00.

Carpenters at $4.50 a day of 8 hrs., $360.00.

The stucco on the upper walls is in two coats—one of ordinary gray cement, and a finish coat of white Medusa Portland cement[3] and silica sand, with a cost, including labor and material, of 70 cts. per sq. yd.

The interior walls are plastered directly on the block, the air space being continuous. The roof is covered with shingles stained green. It is understood that the house made such a satisfactory appearance that the same company has had to build four more similar houses since.

Loose mortar tops on concrete sidewalks are usually caused by the drying out and the setting-up of the concrete base before the top surface is placed and then failure to take the proper precautions to prepare the concrete surface for the mortar top.

The advantage of grading aggregate is to minimize the voids and reduce the actual surface area of the aggregate to which the cement must adhere.

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[2] Simpson Cement Mold Co., Columbus, Ohio

[3] Sandusky Portland Cement Co., Sandusky, Ohio

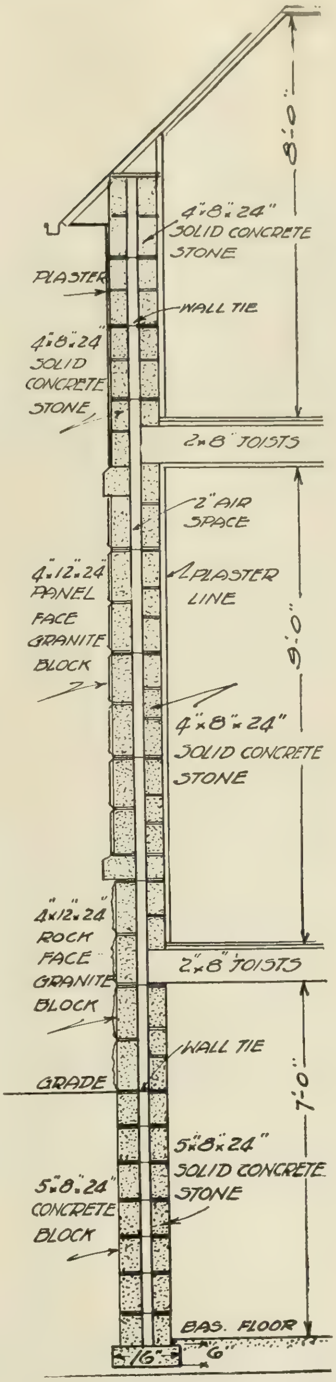
8'-0"
4"x8"x24" SOLID CONCRETE STONE
PLASTER
WALL TIE
4"x8"x24 SOLID CONCRETE STONE
2"x8" JOISTS
2" AIR SPACE
4"x12"x24 PANEL FACE GRANITE BLOCK
PLASTER LINE
9'-0"
4"x8"x24" SOLID CONCRETE STONE
4"x12"x24 ROCK FACE GRANITE BLOCK
2"x8" JOISTS
WALL TIE
GRADE
7'-0"
5"x8"x24" SOLID CONCRETE STONE
5"x8"x24" CONCRETE BLOCK
BAS. FLOOR
16"
6"

Fig. 3—Wall Section of Concrete Block House

Repairing Building Supports and Foundations with Concrete[1]

A common source of annoyance and expense on the farm is the decay or giving way of building supports and foundations. When this occurs it is considerable trouble to replace these with new timber or ordinary masonry. It frequently happens that a building is in first-class condition while its supports have disintegrated or collapsed. For making repairs of this character concrete surpasses any other material. This is due to the fact that it is a plastic substance and may be molded or poured into recesses not readily accessible when another material is used. Timber supports may be renewed without jacking up the building beyond its original elevation.

For example, let it be assumed that a building is resting upon wooden or timber supports which have decayed at the ground level, which always occurs when timber is subjected to alternate wetting and drying. It is an exceedingly simple matter to remedy a situation of this kind with concrete. One has merely to support the building with temporary struts, which should be placed near the post to be removed. The old post should then be sawed off entirely above the rotten part, the suspended part consisting of sound timber. Directly under this suspended post, dig a hole 2' deep and slightly larger than the post itself. Fill the hole with a mixture consisting of 1 part Portland cement, 2 parts sand and 4 parts stone. On top of this place a box with open ends, its inside measurement conforming to the dimensions of the hole. This box should be made and ready to use before any

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[1] From information furnished by the Assn. of Am. Portland Cement Mfrs., Bellevue Court Bldg., Philadelphia

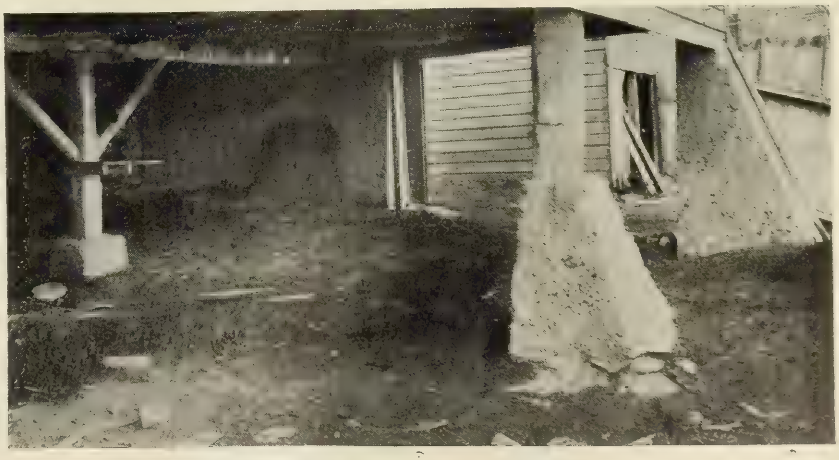

Fig. 1—Repairing Building Foundation With Concrete

concrete is mixed or placed. Its length should be sufficient to reach from the ground to a few inches above the bottom of the sawed support. When in position, fill it with concrete until the bottom of the sawed-off post is embedded about ½″ in the concrete. Proceed as above with each support, leaving the boxes or forms in place for one week, and after two weeks the struts used as a temporary support for the building may be removed. The concrete should be mixed thoroughly wet and tamped or puddled with a stick while being placed.

In the case of large buildings elevated quite a distance above the ground, the new support or foundation may be made larger at the bottom than at the top by sloping one side of the box form, as shown in Fig. 1.

TO REPLACE A CONTINUOUS FOUNDATION WITH CONCRETE

This can be done by the farmer with the help of his farm hands even where buildings are quite large and the foundation is of the continuous type, requiring jacking up of the structure. At necessary points remove a few heavy stones or brick, as the case may be, and insert short pieces of heavy timber to wedge up the building. The building should be carefully raised by this means until entirely free from all foundation. Then remove all of the old foundation and set in place the forms for the concrete. In the case of small buildings it is usually feasible to raise them high enough to allow working room, in which case the form may be filled right up to the top with concrete. The concrete should be a wet mixture consisting of 1 part Portland cement, 2 parts sand and 4 parts stone.

Should the building be too large and heavy to be raised to a height that will give head room, merely make the foundations 3″ wider than the sill. Then when the forms are carried to the desired height the concrete may be inserted through this extra space. To facilitate the placing of the first layers of concrete the top board of the forms may be left off until ready to place the last of the concrete. This last batch should be very wet. The concrete should be tamped until it comes up flush to the bottom of the sill and to the entire width of the wall.

Make certain that a space is left in the concrete wall under and on the sides of the underpinning support so that the building may be lowered onto the new foundation and the timber removed. This opening, of course, must be slightly larger than the underpinning support. The building should not be lowered until the foundation has been in place two weks, and after this is done the openings occupied by the underpinning may be filled with concrete.

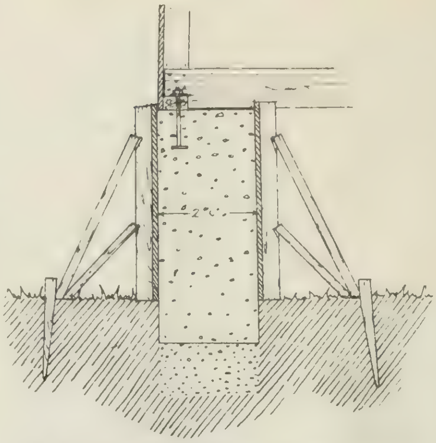

Fig. 2—Detail of Form Work

Fig. 2 shows how the forms should be constructed.

Concrete Pergola, Terre Haute, Ind.

A properly designed pergola adds an indescribable charm to the lawn or garden. It is the finishing touch to the architectural perfection of elaborate grounds and at the same time confirms the artistic character of the modest home. It is equally useful as a dainty frame for a bower of roses or in the more humble mission of supporting the rugged, twisting vines of the grape.

The pergola shown in the accompanying illustration is designed in the Grecian Doric style of architecture and is made entirely of concrete, including the beams and girders. The material used for the facing was white cement, white crushed marble and white sand in the proportions of 2:1:3. All of the work was made in either iron or steel molds. The columns are spaced 8′ o. c. in both directions and consists of two rows of four columns each. The height from grade to top of column is 8′ 8″. The large girders running longitudinally are 5″ x 10″. The crossbeams are 4″ x 8″. All beams and girders are reinforced with corrugated bars. The large beams have four ⅜-in. square rods, and the smaller ones four ¼-in. square rods.

The pergola was erected for Dr. J. D. Roberts, Terre Haute, Ind., and was designed and manufactured by The Pettyjohn Co., Terre Haute. Medusa White Portland cement[1] and Medusa waterproofing[1] were used in the construction.

Concrete Pergola Terra Haute, Ind.

Washes of diluted hydrochloric, acetic or oxalic acid may be used to remove efflorescence, the proportions being from 1 part acid to 4 parts to 8 parts of water.

In the use of artificial coloring matter it is well to remember that the shade will always be lighter in the cured work than when freshly mixed.

Shores should be properly capped with plank or scantling to distribute the pressure, especially where the shores are used to support floor slabs or beams after the forms have been removed.

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[1] Sandusky Portland Cement, Co., Sandusky, Ohio

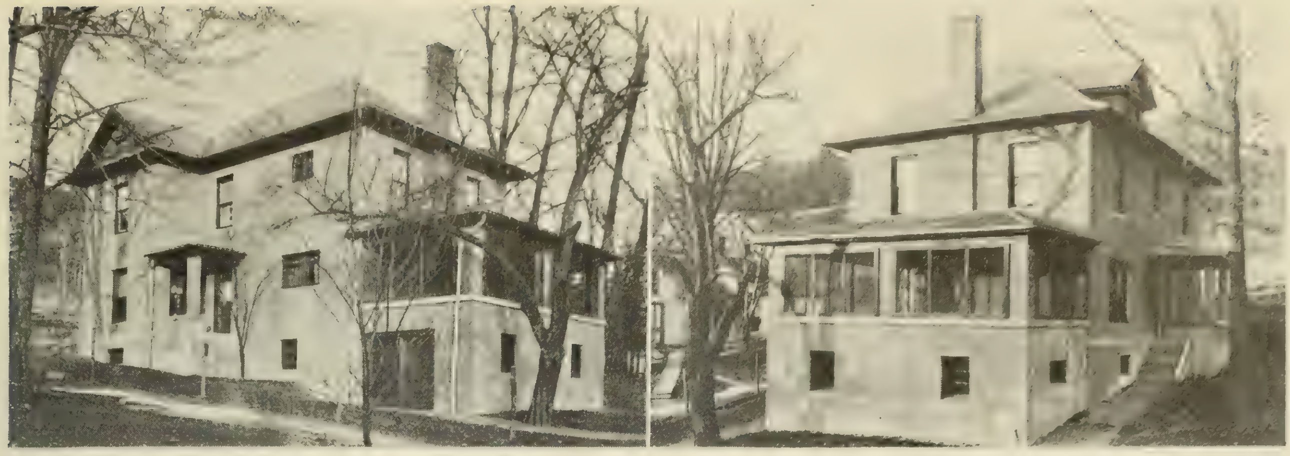

Fig. 1—Two Views of Concrete House with Double Walls, Built in Binghamton, N. Y., for $3,500

Six-Room House, Double Concrete Walls, Costs Complete, $3,500

The 6-room house shown in the accompanying illustrations, 24′ 6″ x 36′ 6″ in plan, has double concrete walls and was built complete last season for $3,500.

It is the home of Otto W. Gall, Binghamton, N. Y., designed by himself and built by William S. Snyder, contr., Binghamton. Information as to the construction and costs is supplied by Mr. Snyder.

Added to the principal plan dimension given is a porch 10′ x 23′. The cellar is 7′ 6″ in the clear; height of first uoor 9′ 3″, second floor 8′ 10″, full height of house to roof plate, including cellar, 26′ 6″. A Van Guilder[1] hollow wall machine was used in the construction.

The material required for outside walls including footing; cellar walls, superstructure and porches, was 116 cu. yds. of bank-run sand and gravel, at $1.25 per cu. yd.; 124 bbls. Atlas[2] cement at $1.40 per bbl. The concrete was mixed 1 part cement to 6 parts sand and gravel; $28 worth of wire ties and reinforcing were used. Workmen employed were: one operator on hollow wall machines at $4 per da., and four helpers at an average of $2.25 per da.; 21 das. were occupied in the work. A mixer with a hoist attached[3] for carrying the concrete to the double wall machines

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[1] Van Guilder Hollow Wall Co., Rochester, N. Y.

[2] Atlas Portland Cement Co., N. Y. C.

[3] Jaeger Machine Co., Columbus, Ohio

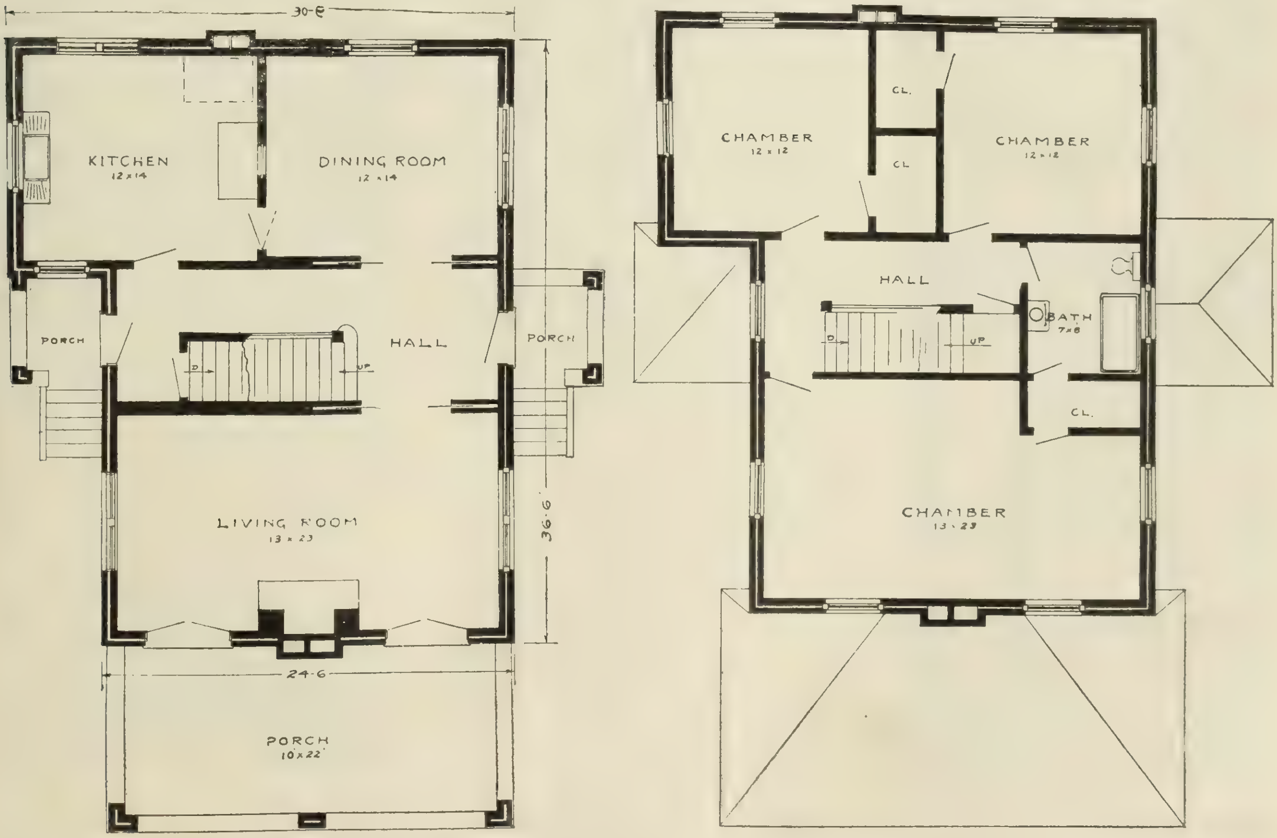


Fig. 2—First and Second Floor Plans, House in Binghamton, N. Y.

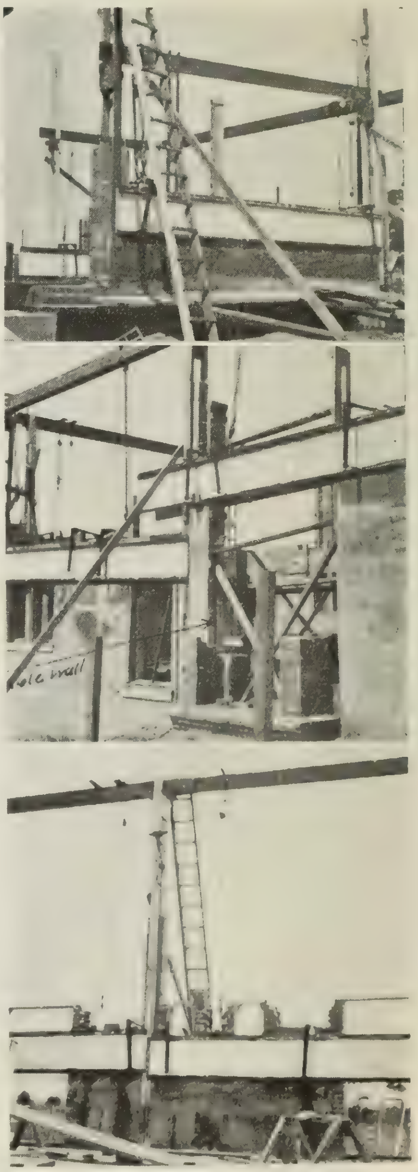
Cost and Construction Details of Double Wall House on Long Island

Notes on the construction of a large concrete residence at Lawrence, L. I., for J. S. Carvalho, N. Y. C., and the accompanying illustrations the supplied by G. S. Mumford[1] as follows:

The building was erected by the Unit-Wall Construction Co., N.Y.C., by its system for hollow concrete walls on which interior plaster is applied directly.[2]

Although the house is on the shore of Jamaica Bay and subject to fogs and gales off the ocean, no dampness, condensation nor leakage of any kind has occurred.

It was developed in the course of construction that it is possible to use large quantities of fine sea sand combined with ordinary gravel and obtain excellent results. In this case the following proportions were used in all walls above the foundation: 1 part cement, 2 parts fine sea sand and 4 parts ordinary gravel passing a ¾-in. ring. This mix was turned once before putting in the mixer. Sufficient water was used to give a product wet enough to flow down a steep chute but not so wet as to allow any separation of excess water from



Figs. 1, 2 and 3—These Show the Unit Wall System in Operation, With Special Hoisting Apparatus to Raise Unit Form Sections and Inner Core Form

was used. A charge of $1.00 per da. was made against the house for the mixer.

The footing under the cellar wall is of solid concrete 18″ wide by 12″ deep. The cellar walls, 8′ high, have an outside wall 6″ thick and an inside wall 4″ thick, with a continuous air space between them, but are bound together by many galvanized iron ties with bent ends running from the middle of one wall across the air space to the middle of the other wall.

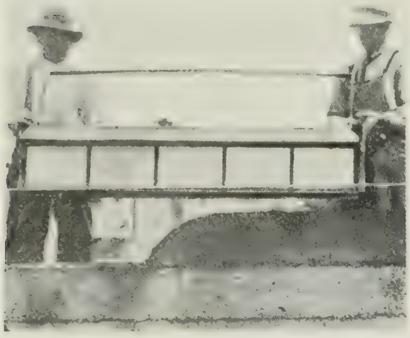


Fig. 3—Wall Machine in Use

The superstructure and porches have double 4-in. walls with the same air space and ties. Each wall is reinforced with wire all around the building every 9″ in height. The chimney is a part of the concrete wall itself.

The entire cost of the concrete work on this house, including footing, cellar walls, superstructure, porches and chimney, was $640. The cost of the walls, including 1 ct. per ft. for investment in machines and depreciation, was 16 cts. per sq. ft. of wall surface. No wooden forms were used; the machines did all the work except the steps leading to the porches and the chimney above the roof.

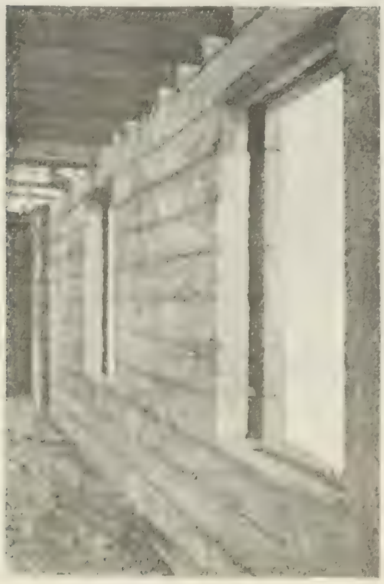


Fig. 4—View Showing Double Wall Construction

Plaster is applied directly on the inside walls, the insulation provided by the air space making furring and lathing unnecessary. Dampness will not penetrate the interior and condensation is prevented. The amount of plaster required is somewhat less than when placed on lath.

The stucco finish is applied directly on the outside walls, the machines leaving a rough surface for its application. On this house three coats were used composed of light colored sand, Atlas cement and hydrated lime. The third coat was applied with a whisk broom, producing a whip effect. The walls are entirely of concrete and steel.

Inside the house the first and the second floor are double; first floor finished in oak; second floor finished in N. C. pine; floors filled and varnished; all partitions throughout house, except where sliding doors run, are 6″ thick; partitions where sliding doors run, 8″ thick; floors of kitchen and bath room of composition flooring; kitchen trim, N. C. pine, natural finish; all other trim of lower floor, including stairway, cypress, finished with one coat dark mission stain; all second floor trim, N. C. pine, three coats white enamel; hot air heat; electric lighting; straight gas kitchen. Outside trim, cypress stained with tobacco brown creosote; slate roof; cost of house to the owner, complete, $3,500.

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[1] Pres., Unit-Wall Constr. Co., N.Y.C.

[2] See Concrete-Cement Age, Mar., 1913, p. 135, and May, 1913, p. 218

the aggregate. No tamping was required.

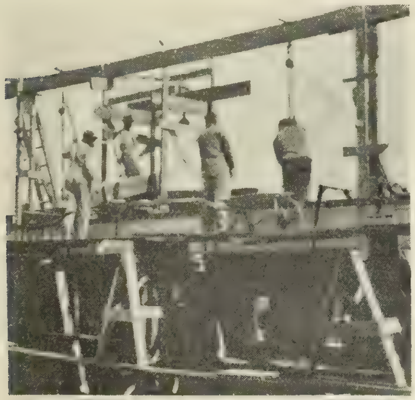
Forms were shifted once every 8 hrs. on the average. The resultant cast was extremely favorable to plaster and stucco application, as surfaces pitted with fine pores were obtained which gave an ideal bond. While the mix used will not result in a cast of high tensile strength, the strength developed was ample for the loads involved and a wall was obtained uniformly dense and homogeneous. In several cases where loads were negligible and the wall limited as to length and height, as much as 3 parts sea sand to 3 parts gravel were used.

The system used by the builders, comprising hidden columns of reinforcement tamped concrete tile tied together over window and door lintels by tiers of divided reinforced concrete beams, permitted this experiment in aggregate to be made with comparative safety.

The cost of commercial gravel in this locality varied from $1.75 to $2.25 per yd. The sea sand was obtained from the cellar excavation, being the fine sandy silt just below the top soil and clay common to this section.

The total concrete yardage in the walls was 385, the dimensions being 62′ 6″ x 41′ 6″ x 33′ 6″, footings to plate. The time of erection of walls above first floor beams was 14 working das.

The conveying apparatus used consisted of a 5-cu. ft. mixer[3] with hoist and bucket dumping into a very short steep chute, which in turn emptied into wheelbarrows. No scaffolding whatever was erected, runways over horses and on second floor beams being substituted.



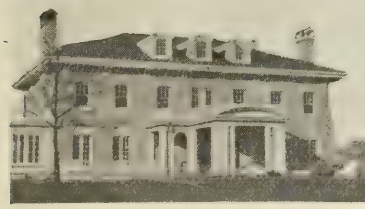


Fig. 4—Runways for Handling Concrete in Wheelbarrows to Forms

Fig. 5—The Completed House at Lawrence, L. I.

The cost, (including setting and shifting of forms, depreciation, etc.) averaged throughout $5.50 per cu. yd., divided approximately as follows

Gravel, 2-3 yd. @ $1.75	$1.17
Sand, 1-3 yd. @ $0.21	.07
Cement, 1.6 bbls. @ $1.45 net	2.40
Labor—mixing and placing	1.40
Labor—Shifting runways, scaffolding and forms, including gasoline and depreciation	.50
	$5.54

As the walls largely consisted of two 4-in. slabs, each sq. ft. of wall surface represented the equivalent of ⅔ cu. ft. which gave a cost per sq. ft. of wall surface of 14 cts.

By this system, window and door openings are handled by placing the window or door frame in the wall and running up a brick or tile jamb on each side of the frame previous to pouring concrete up to and around it. By this means large forming expense to obtain true arrises is obviated.

The double concrete walls were formed by using a sheet metal core lined with zinc on the outside to prevent adhesion of concrete. These cores were non-collapsible and rested on the tops of the side forms, their supporting arms acting as spacers. By means of special hoisting apparatus supported from above, the side forms and cores were raised as a unit, it being found practicable to withdraw the cores from the wall by means of the hoisting power gradually applied. To aid this a petroleum mineral oil was used profusely on the cores. These cores were in standard 2-ft. sections and to bridge gaps thin sheet iron side pieces supported from and lapping cores were used. In many places near and between close-set windows it was found more convinient to insert a 3-in. tamped concrete tile block than to use a core mold; this did not materially increase the cost and greatly aided the speed of operation.

To avoid the great expense of making chases for numerous floor beams a system of headers and trimmers was used, beveled wood blocks being left in the wall to which the headers were spiked at short intervals. This also greatly strengthened the walls.

The exterior trimmings and porches of this building are of masonry covered with a 1:1 white cement and marble chip facing with the exception of the balusters which are of marble chips and white cement rubbed down after casting. To avoid joints and cracks, the bases, caps and neckings of the columns were cast on after the columns themselves were in position and finished. It was assumed that by so doing the well known principle of "shrinking on" would act to prevent cracks and also allow a large amount of connecting reinforcing steel to be dispensed with. This operation was very successful and up to date no cracks have appeared. All porch roofs were tarred and then covered with a thin layer of reinforced concrete.

George C. Walters Dead

Just as Concrete-Cement Age goes to press, announcement is received of the death, Dec. 19, 1914, of George C. Walters, President of *The Concrete Age*, Atlanta, Ga. This news will come as a distinct shock to the men who were brought in contact with him at the meetings of the cement and concrete organizations all over the country. Mr. Walters was an enthusiast and took an active part in the old National Assn. of Cement Users. He was a well known figure at the Cement Shows and he will be missed at future meetings. His ready cordiality and his evident sincerity made him a man whose hand it was always a pleasure to grasp, and there are many who looked forward to meeting him at Chicago next month.

The death of Mr. Walters, while it came quite suddenly, was not entirely unexpected. He had been in poor health for some time and had been obliged to give up some of his many active interests. The real sympathy of the entire staff of Concrete-Cement Age goes out to our esteemed southern contemporary, which has lost from its organization a man and a gentleman.

Acid Washing

In regard to treatment of concrete products with acid for the removal of the surface film of cement, I think, from the standpoint of economy, the treatment in a tank for small pieces is the cheapest. But for larger pieces, the use of a rough brush is more advisable. I use no tanks for my work but use brushes and a solution of half acid and half water, after the goods are one day old, and clean off with clear water. The results I have with this method are satisfactory to me.—Julius Ruoff, Philadelphia.

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[3] Waterloo Cement Corp., Waterloo, Ia.

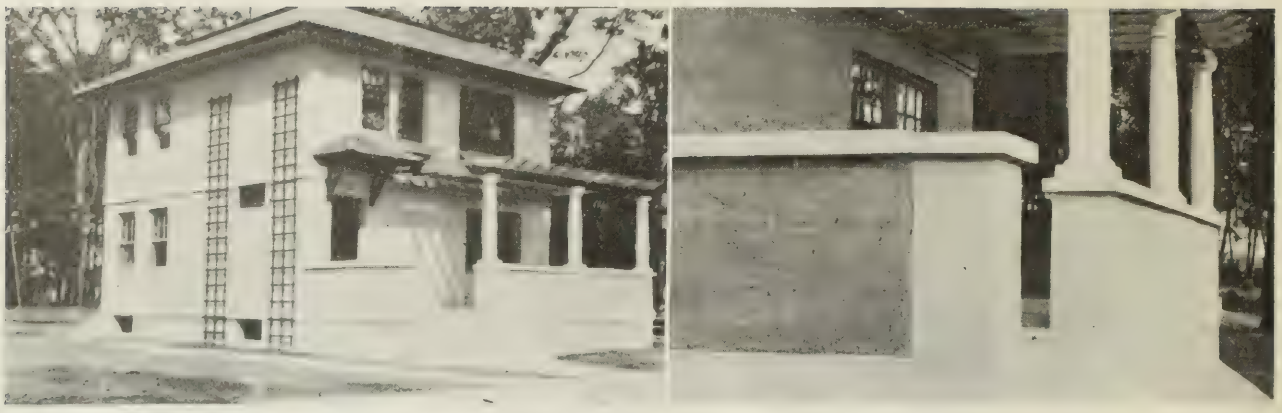

Fig. 1 Completed Concrete House, Springfield, Mass., and Detail Showing Surface Finish

Two-Story House With Walls and Floors of Concrete, Built for Less Than $3,000

The two-story house shown in Fig. 1 is 24′ x 25′ in plan. It was erected in Springfield, Mass., and the cost was under $3,000. Walls and floors are of concrete. The following descriptive notes and itemized costs were supplied by Walter Denman[1] who was in charge of the work described.

The Lambie steel forms[2] were used. These forms are the evolution in actual practice in the field of the use of a steel channel-shaped unit which may be set vertically for the entire height of one story and also for the floors without the use of shoring, bracing or wiring. The standard unit is a 9-in. channel punched with ½-in. holes about every 10″ with each leg of the channel punched in two locations to receive a small angle which acts as a lock and a liner.

The plates are fastened together with very simple clips and wedges which hold them rigidly in place and are very quickly placed or removed. Openings for windows and doors are built into the forms and the window frames may either be placed before pouring the concrete or rough wood stops may be used and the frames placed with plastic waterproofing after the forms are removed.

The liner lock is used in the inner wall form to receive adjustable I-beams at the proper height below the ceiling line to receive the floor plates. These plates are interchangeable with the wall plates and the workmen do not need to select any special plates as a rule but seize the first one at hand and place it either in the wall or the floor as the case may be.

In the construction of the house at Springfield a foreman who was a carpenter was employed on the job and after laying the first floor he thought it would be advisable to use 2-in. plank for the next floor. The plank were provided and he started to place them but after laying three or four pieces and noticing the irregularities in line and level he quickly discarded them and returned to the plates, finding that they were cheaper to handle and more quickly placed and that they also served to bring the walls to an immediate and rigid alignment.

At the top of the inner wall forms is placed a release angle 3″ in height which fastens on to the upper ends of the plates, the top of which is exactly level with the top of the floor plates. This release angle is of great importance in the building and will be referred to later.

The best method is to set up the inner wall forms, partition walls and floor forms before setting any of the outer wall plates. Before setting the latter forms, nailing strips and steel reinforcement are attached to the inner forms. The reinforcement in the walls consisted of ½-in. rods spaced 18″ o. c. in both directions. While the inner wall forms were being set, loops of 16-ga. wire were passed through between two plates, being spaced every 4′, each wire passing around one of the clips.

When one side had been set up a man and a boy put on the wooden nailing strips which were cut 2″ wide on the side embedded in the concrete, 1½″ on the face of the wall and 1″ thick, this beveled form holding them perfectly in the concrete and thus serving the purpose of nailing strips to which the furring strips might be fastened. As soon as this was done, the outer form was begun at one corner and two gangs of three men each rapidly placed them around the house.

On top of the outside row of plates is placed horizontally a belting course made of an 8-in. channel which is punched about every 4′ with one ½-in. hole. As soon as the inner and the outer forms are set the reinforcement, consisting usually of 2-in. plain rods, is laid upon the floor and naturally kept away from the surface of the floor about 1½″ by temporary risers until the concrete is placed. Where these reinforcing bars come opposite the holes mentioned in the belting course the ends are threaded and a 2-in. sleeve nut put on, into which is inserted a 6½-in. bolt which passes through the hole in the belting course. The adjustment of these bolts and nuts brings the belting course into perfect line and holds it there.

The concrete is then poured, using a mixture of approximately 1:2:4 as wet as is consistent with good practice. This pouring naturally starts with the walls, running until filled to the floor level and then the floor is poured monolithic with the walls. Openings are of course left in the floor for stair wells, plumbing, etc., while the electric light conduits are placed directly in the floor slab. The walls and floors of the house in Springfield are 6″ in thickness, the longest span of the floors being 12′ 3″.

It was found that it was possible to remove the outer forms from the wall 24 hrs. after pouring the concrete, as there were no wires, bolts or anything else passing through the walls and holding the forms together. The bolts above mentioned are in the floor and the belting course is not disturbed until after the succeeding floor has been poured and the forms removed. The outer wall forms are passed up to the floor just poured and are immediately set up as an inner form and as soon as this is set the removal of the inner wall forms is at once begun. For the average house it usually takes but one day to remove the outer wall forms, finish the surface by brushing it out, and reset these forms for the inner face of the next story.

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[1] Consulting Engr., Springfield Mass., Treas., Lambie-Demman, Inc.

[2] Their use in house construction at Midland, Pa., for the Pittsburgh Crucible Steel Co. was described in Concrete-Cement Age, April, 1914, p. 159. For further details of the form unit see Concrete-Cement Age, May, 1913, p. 255

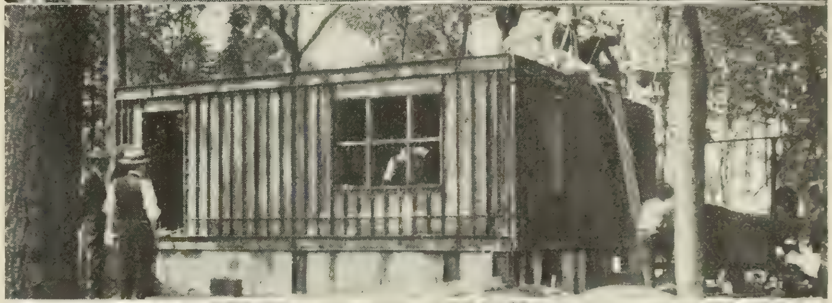
It is in the removal of the inner wall forms that the release angle proves its tremendous value, for by leaving in place an occasional single 9-in. plate supporting the adjustable I-beams above referred to, and carrying the floor plates and concrete floor, the release angles can be taken off, allowing the wall plates to be removel without disturbing the floor plates in any way. Another very simple way of doing it has been to put temporary shores under a few of the plates, removing the adjustable beams entirely and taking out all the inner wall plates as well as the release angles. The inner wall plates are then passed up to the next floor and set on top of the belting course to which they are fastened by clips and wedges.

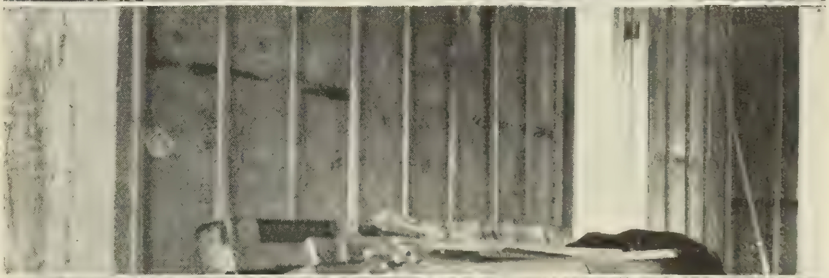
It will be observed that for rapid practice a sufficient quantity of plates is required to set the inner and the outer wall forms for two floors and a sufficient number of belting course pieces to go around the house on two floors.

A very remarkable saving in the cost of finishing the surface of the concrete was made by the quick removal of forms so that the surface could be either rubbed or brushed out while green.

With a gang of eight men it was found at Springfield that the outer forms for the last story could easily be removed in one day and the surface brushed out with bristle brushes and clean water to expose the pebble aggregate. In order to get contrast the belting courses were rubbed smooth and the wall spaces between the floors were brushed out to expose the aggregate, and a careful examination of all of the walls of the house failed to show any form marks. It was, however, found, as is often the case, that the aggregate so brushed out showed the joints between the various layers of concrete even though it was poured consecutively and withuot any stoppage whatever but it took a half hour to make a complete lift around the outside walls and in that time the heavy aggregate had slightly settled, leaving a very thin section of the finer materials which naturally shows in the walls, although not offensively.

In the construction of the first house at Springfield the labor cost of setting and removing the forms was found to be in the neighborhood of 4 cts. per sq. ft. but it must be taken into consideration that this was done





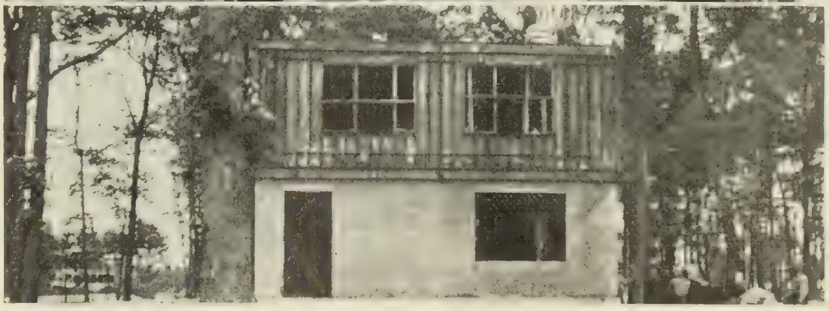


Fig. 2—Inner Basement Forms Set and Nailing Strips and Reinforcement Being Placed

Fig. 3—Placing Reinforcing for Floor

Fig. 4—Cellar Forms Removed and Set for First Story Walls and Second Floor

Fig. 5—Furring Strips of Interior Ready for Plaster Board

Fig. 6—Forms Removed From First Story, Walls Brushed Out and Forms Ready for Pouring Second Story Walls and Ceiling

by a crew of men who had not only never seen steel forms but who, with the exception of the foreman, were common laborers, with only the average intelligence of this class, and it is worthy of note that in setting the forms for the second house this cost was reduced by the same gang of men to 1.6 ct. per sq. ft. for the labor of setting them, while the labor of removing is considerably under ½ ct. per ft.

For the floors the usual method was carried out of placing screens 12″ o. c. and filling between with a very lean mortar to make a bearing for ⅜-in. clear maple flooring. The kitchen, bathroom and front vestibule were covered with red Karbolite,[3] making a floor that can be mopped with hot or cold water. The walls were furred with 1-in. x 1-in. furring strips placed 12″ o. c. and fastened to the nailing strips described above. On them was placed plaster board, with one coat of plaster, tinted later in pleasing pastel colors. These furring strips also act as a ground for the base board, window and door trim.

Partitions were made throughout the house by using one thickness of Keyridge[4] which was fastened to the ceiling and the floor and plastered on both sides. The stairway leading from the first to the second floor is unique in its construction—made by driving holes into the exterior wall to raise a ½-in. rod in the top and the bottom of each riser. The other end of the rod was put into the Keyridge partition on the opposite side of the stair well and the rods then covered with expanded metal lath of 22-ga. to form the base for treads and risers. It was then covered with 1″ of 1:2 mortar made of Portland cement and sand put on in two coats and also back-plastered with the same material. Mason safety treads, 3″ in width, were placed in the treads of the stairway. The Keyridge partition which carries the rods was plastered with 2″ of cement mortar and the stairway thus became very rigid. The construction appeared rather light before it was plastered but it was found that the bare rods and mesh carried the weight of the average man on any tread with no trouble at all and on completion would carry 500 lbs. on any tread.

On the front of the house instead a roofed porch a pergola of wooden rafters was placed on concrete columns made in a Goshen column form.[5] A small hip roof was built over the front doorway and covered with cement shingles which are used over the bay window and on the roof of the house.

The roof shown in the illustration is really a false roof as the ceiling on the second story is a 6-in. slab of concrete sloping slightly from the center towards the outer walls and thoroughly waterproofed; but in order to add to the appearance and also to make the upper rooms cool in the hottest weather, a false roof was built with timber frame and on it were laid concrete shingles made in the Hansen shingle machine.[6] These shingles are made of 1:2 mortar and are colored with pure oxide of iron, giving a very pleasing red roof which sets off the house very nicely.

The woodwork and the pergola rafters were painted moss green and the general effect of the house is extremely pleasing although the lines are very simple. It may, however, be accepted as axiomatic in concrete that the simpler the lines of concrete architecture, the better the final effect.

The house has a living room 11′ x 18′, a dining room 12′ x 12′ and a kitchen 9′ x 10′ 6″ on the first floor. On the second floor are a bathroom 6′ x 8′, two bedrooms each 9′ 6″ x 11′ and one bedroom 9′ 2″ x 10′ 4″. A fireplace was built into the dining room and ample closet room is provided throughout the entire house. The complete cost of this house is in the neighborhood of $2,885.00, including the work above described and the plumbing, heating and lighting. Costs are itemized as follows and do not include superintendence nor profits.

ACTUAL COST OF SPRINGFIELD HOUSE

Cement, 150 bbls. at $1.60	$ 240.00
Sand, 50 yds. at 30c.	15.00
Gravel, 90 yds. at $1.40	126.00
Mix and place 123 yds. at $1.67	204.50
Labor on forms, 9,888 sq. ft at 3.6 cts.	355.97
Reinforcement placed, 5,400 lbs. at 2½ cts.	135.00
Surface finish, 3,860 sq. ft. at 2.4 cts.	94.00
Fur and plaster, 200 sq. yds. at 50 cts. (contract)	100.00
Partitions, 75 sq. yds. at $1.40 (contract)	105.00
Millwork	315.00
Lumber and carpenters	275.00
Hardware	43.00
Maple floors	103.00
Flue liners	15.50
Jahant furnace (installed)	125.00
Plumbing (contract)	210.00
Electric fixtures and wiring (contract)	100.00
Fireplace	35.00
Painting (contract)	92.00
False roof	102.00
Nails and miscellaneous	26.00
Royalty, 2½%	70.00
	$2,886.97

Members of CONCRETE-CEMENT AGE's staff will be glad to meet you at the Chicago Cement Show—Feb. 10-17.

New Books

Concrete Roads and Pavements. By E. S. Hanson, Revised Edition, cloth, 5¼″ x 7¾″, 338 pp., illustrated. Cement Era Publishing Co., $1.50.

The publication of this new and considerably enlarged edition of Mr. Hanson's book, following the original edition within a year, is strong evidence of the reception the book received and of the rapid development of concrete road and pavement work. The new book is 50% larger than the first edition, additions having been made to various chapters and considerable entirely new subject matter introduced. The book is the only work so far available for road builders which comes anywhere near an adequate consideration of concrete highway construction within the compact space between the covers.

Chemical Reagents; Their Purity and Tests. Authorized translation of *Prüfung der Chemischen Reagenzien auf Reinheit (zweite Auflage)* von E. Merck. By Henry Schenck, A.B. (Harvard). Second edition, 1914, cloth, 6″ x 9″, 199 pp., including index, D. Van Nostrand Co., $1.00 net.

Several improvements have been made in the new edition of this well known work; for example, many new uses of, and methods of testing the reagent chemicals are described, as also new reagents which have come into use; likewise the addition, in parenthesis, of the percentage of the minimum amount of the impurity which the test would recognize.

The table at the end of the book on the preparation of test solutions, with brief instructions for making them, is of value. Altogether the work is one of great value to chemists, and should be found in every laboratory.

The index of authors, to whom reference is made, and their work, is of value. The subject index is a convenience, although the work is arranged alphabetically; and it constitutes a good cross-reference list.

The present decade marks many new uses for cement and none more important than in mines and mining operations. At the 60th general meeting of the Institution of Mining Engrs. held recently in London an interesting paper was read dealing with the sinking and equipment of a large coal mine in the Durham district in England.

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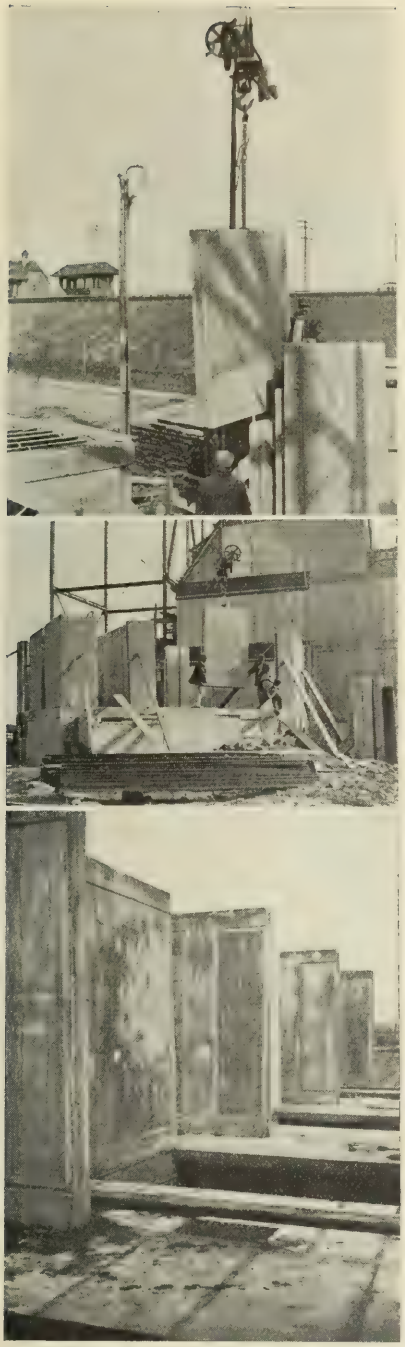
[3] Mason Safety Tread Co., Boston

[4] Edwards Mfg. Co., Cincinnati

[5] Goshen Cement Column Co., Goshen, Ind.

[6] L. Hansen & Co., Kansas City, Mo.

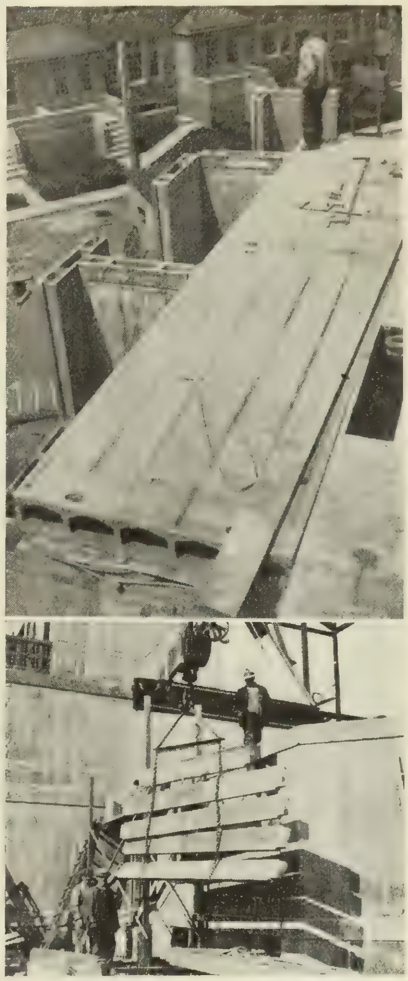


Figs. 25, 26 and 27—Wall Slabs Being Set in Place—Note Paneled Inner Surface in Fig. 27

Houses at Forest Hills Gardens

(Continued from page 8)

moved to and from the building operation on the same industrial rails used for the transportation of units, can be moved by means of its own power, or, as was the case after completion of this group, hauled by an ordinary heavy steam roller. Fig. 17 shows a portion of the excavation ready for the first three houses with the footings laid and leveled, and the crane moved up to the edge of the excavation ready for operation. This crane has a lifting capacity of 5 tons with a swing of 270°, a 40-ft. hoist and a 40-ft. clear reach, so that it could put the chimney tops on this group of houses, substantially equivalent to three stories in height. It is obvious that such an equipment and layout are too elaborate for economy in any but large operations, the derrick alone costing $7,000 or $8,000.



Figs. 28 and 29—Above is Shown Floor Construction with Hollow Slabs; Below Floor Construction with Pre-Cast Beams, the Beams Being Hoisted Into Place

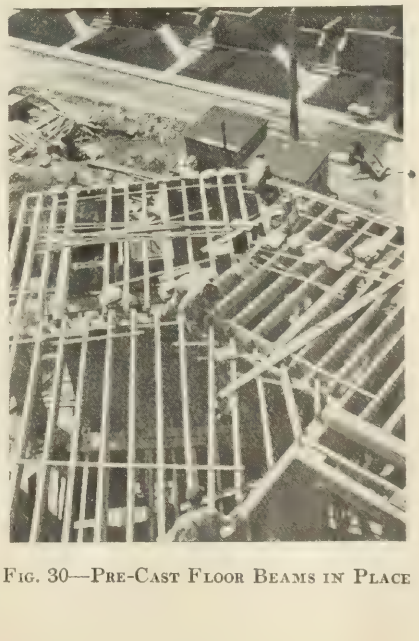


Fig. 30—Pre-Cast Floor Beams in Place

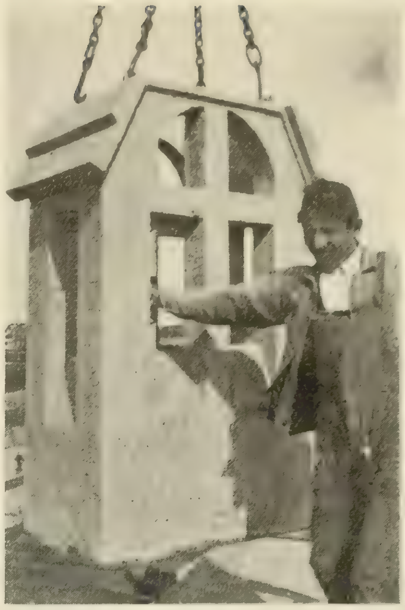


Fig. 31—Ornamental Chimney Top Being Lifted Into Place

The subsequent illustrations of the process of erection need very little further explanation, the progress of the first section of the group being shown in Figs. 17 to 24, and detail views illustrating methods of handling and various types of sections in Figs. 25 to 31.

The electric crane, operating above the storage yards, lifted the foundation block onto cars which followed the tracks laid down for the derrick, and were relieved by it of their burden which was swung into place on the footings already prepared. When all the foundation walls were in place they were bedded solidly upon their footings by grouting from on top through the core holes and by this method also the tongue-and-groove joint was made perfect. In this group all joints were later coated from the outside with oakum and pointed up over it.

In the original experimental house erected the floor and wall sections contain rabbets, so as to give a mechanical obstruction to leakage from the outside. This was entirely satisfactory; and in the second house an experiment of omitting this mechanical lock was tried in order still further to economize in the cost of manufacture. For more than a year there was no trouble even under these conditions, and in view of that experience the same design was adopted for the group at Forest Hills Gardens. Later on, however, trouble was experienced with these straight joints; and as it was too late to modify the design the caulking process was resorted to in order to avoid any trouble of this nature. Obviously in future operations the rabbet will again be introduced, experience having shown that the only vulnerable point is the joints, and almost entirely in the horizontal ones. In no case has experience shown that dampness has made its way through properly cast hollow wall sections of the design here illustrated.

In placing the units, the crane actually handled 2,000 cu. ft. in a day, not working by any means to its full capacity but handling all the units which could be placed and grouted by eight men. Two of these men attended to placing and six to grouting.

When the basement tier of wall sections had been set and grouted the floor slabs were in turn hooked up by the four corners and laid in their proper positions on the basement slabs and similarly grouted in place. The outermost floor slabs show through the wall, project over it a little and are provided with a wash and drip. The exposed surface was usually arranged to be a closed side, but when the naturally cored end of the slab was exposed it was plugged and finished like a side adjoining floor slab and its ends and sides were anchored together with iron straps let in and grouted. Abutting ends were grouted together and for this purpose thin sheet metal caps were placed over the upper ends of the wall slabs which carried them so as to hold the grout. Upper walls and floors were similarly constructed.

As will be seen in Fig. 28 wall slabs adjoining an opening have a groove toward it into which were slipped wooden window and door frames. It will be noted that every floor shows through and that every feature of construction writes itself on the outside of the building so that he who runs may read. This is the gospel of architecture and it has scarcely ever been so closely attained in anything but a concrete building.

Pre-casting concrete slabs insures scientifically placed reinforcement, uniform setting and sufficient curing. It is attended by none of the difficulties of adverse weather conditions, untrueness of forms, and unpreparedness for load carrying which are the nightmares of the monolith. It makes possible the use of casting machinery and standard molds, so as to avoid wastage of all kinds incident to ordinary casting work *in situ;* it permits, as well, a reduction of the factor of safety to a more scientific point both in materials and design; it offers opportunity for all the economies incident to factory conditions.

Quite apart from its economic aspects, its stability and its fireproofness—properties common of course to all properly built concrete structures it is evident from the demonstration described that there is a further distinct advantage in the important saving in time accomplished under any system which manufactures a house substantially in the factory instead of on the scaffold, as has been the ordinary custom. Up to the present Mr. Atterbury's system of standardized hollow sectional construction requires a plant incompatible with economy in small operations, but the same might once have been said about erecting structural steel.

To an architect the most satisfying thing about this crescent of concrete dwellings, set in sharp competition as to appearance with some of the best small suburban houses in America, is that the group holds its own in color, texture and design in spite of the fact that it is composed of "standard" sections made out of ordinary sand, gravel and cement, and that the manufacture of the floor and wall sections of the entire group of houses was accomplished with only six steel molds.

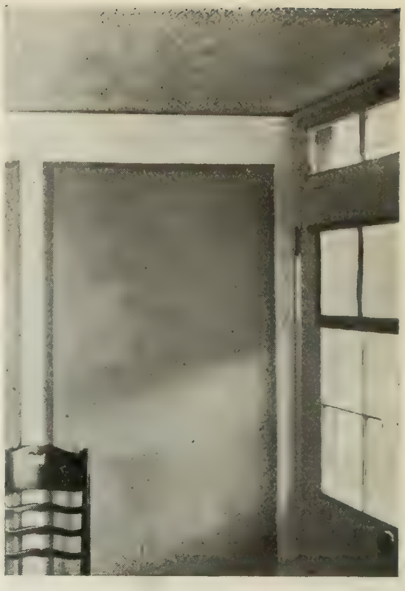


Fig. 33—Interior View of Wall and Ceiling

Joints between day's work in concrete construction should be at same feature line, or be made truly straight and level.

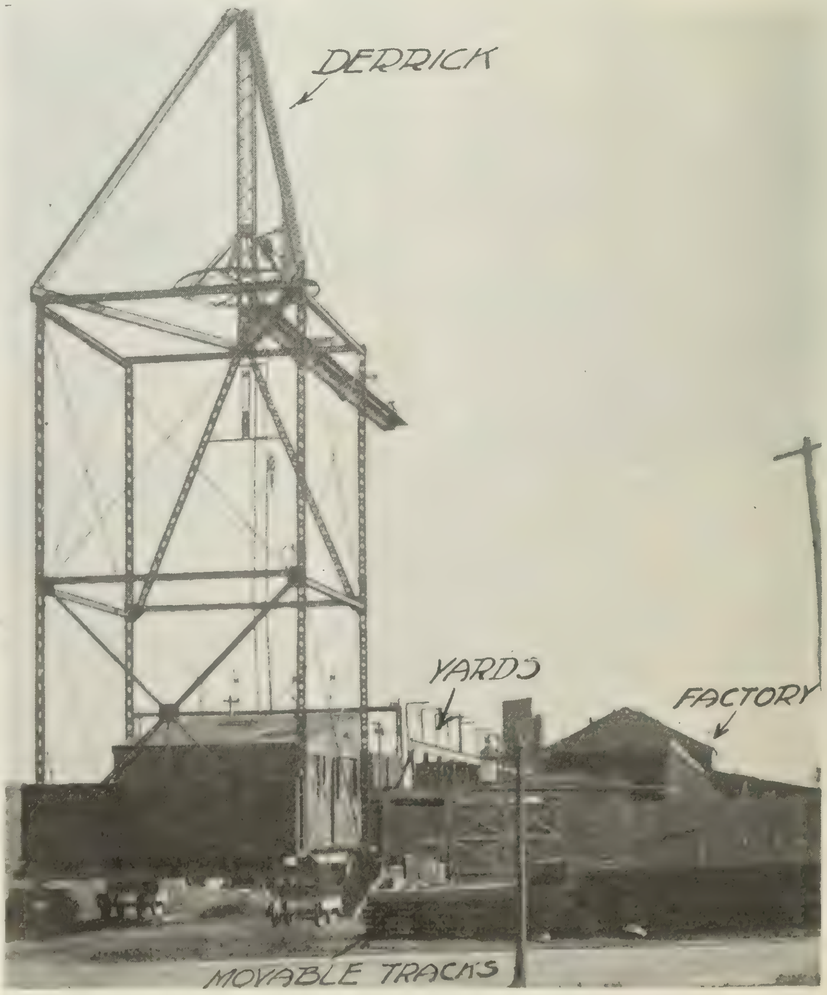


Fig. 32—View of Forest Hills Gardens Factory and Movable Crane or Derrick

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa. Convention, Auditorium Hotel, Chicago, Feb. 9-12, 1915.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago. Convention, Chicago, Feb. 15 and 16.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager. Show, Chicago Coliseum, Feb. 10-17, 1915.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

Mid-West Cement Show, Omaha, Neb., Mar. 2-6, 1915.

National Conference on Concrete Road Building, J. B. Beck, Sec., 208 S. LaSalle St., Chicago.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention, Omaha, Mar. 2-6, in connection with Mid-West Cement Show.

The Cement Show, Chicago, Feb. 10-17

The annual Cement Show of the Cement Products Exhibition Co., in the Coliseum, Chicago, Feb. 10-17, is something which contractors, architects and engineers cannot well afford to miss.

It has been commonly supposed that this show is for the "concrete man." And who is the *concrete man?* Nowadays he is practically every man who is designing or constructing buildings, roads, bridges, dams, sidewalks, silos, sewers, or factory-made units. The general contractor who is not fully equipped to do concrete work is no longer a general contractor. As the progress in concreting is wonderfully rapid from year to year, it is not only true that more architects, contractors and engineers have occasion to use the material but that they must keep abreast of that progress and familiarize themselves with the materials, methods and equipment involved in the use of concrete or else lose step in the procession. The Cement Show is the biggest single opportunity of the year.

In many sections of the country building operations—construction in general—have slackened, yet where work has been stopped, there will be more work to be done this year. Everywhere there is ample evidence of a return of activity, with the railroads—always an index—leading the van. In the particular case in hand perhaps the best indication of the outlook in the construction world is in the fact that every inch of exhibition space, the management announces, has been sold.

Another reason why Chicago should be the Mecca Feb. 10-17 is the fact that at that time of the Cement Show conventions will be held in Chicago by the Am. Concrete Inst., Am. Concrete Pipe Assn., Nat. Builders' Supply Assn., Illinois Assn. of Municipal Contractors, and Illinois Lumber and Builders' Supply Dealers Assn.

Am. Road Builders' Assn. Convention and Exhibition

The fifth American Good Roads Congress and the 11th annual convention of the Am. Road Builders' Assn. were held in Chicago Dec. 14-18, 1914. The exhibition of roads, road materials, machinery and accessories, in the International Amphitheater at the Stockyards, was probably the most pretentious in extent ever held.

It was a long way from the downtown stopping places of most of those attending the Congress, but when the delegates finally reached the place, they remained, in most cases, throughout the day. The central arena of the Amphitheater held a parked space surrounded by a track in which were sample sections of practically all types of pavement. Outside this track were the exhibitions of municipalities, states and of the U. S. Office of Pub. Roads. In one wing of the Amphitheater was machinery and in the other wing were the materials and accessories. The machinery exhibit attracted a great deal of attention and there were two distinctly new things to be seen, of especial interest in the concrete field, a big road mixer[1] equipped for caterpillar traction to obviate the use of planking on the sub grade; and another mixer[2] with automatic batch indicator to be set to ring a bell when a batch has been turned a desired number of times and to count the batches, as a check upon cement and other material quantities. Both these new items of equipment will be described in an early issue.

The meetings of the convention were held in a hall at the Stockyards Inn, immediately adjoining the exhibition building, and for the most part the program carried out was as previously announced in this magazine.

Monday, Dec. 14, was registration day. Tuesday was Chicago and Illinois day, with addresses of welcome, responses and a general program. Wednesday, Thursday and Friday were the most valuable days for the road builder. There was generous provision on the program for discussion of practically all of the papers presented, though this was not taken advantage of as fully as could have been desired. If a general criticism were to be made it would be that there should have been more discussion. It was sometimes necessary to cut short the discussion of one paper to allow time for another paper to be read.

Material presented at the convention having special bearing on concrete road and pavement work will be published in the Feb., 1915, issue.

National Lime Mfrs. Meet in Washington, Feb. 3-4

The annual meeting of the National Lime Mfrs.' Assn. will be held in Washington, D. C., Feb. 3-4, 1915, at the New Willard Hotel. This meeting will afford an opportunity to observe the investigations of the different classes of materials for plastering, lime, gypsum, cement mixtures, etc., that are being conducted in the Bur. of Standards. A strong effort will be made to overcome the prejudice on the part of the Treasury Dept. in the omission of lime from its specifications for public buildings, and this can be done only by bringing engineers and architects, interested in the subject, to the meeting. It is expected that Dr. Stratton, chf. of the Bur. of Standards, under whom the investigation of lime is being conducted, will be in attendance.

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[1] Municipal Engrg. & Contr. Co., Chicago

[2] Koehring Mach. Co., Milwaukee

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field. □ □

A Metal Spraying Process for Coating Ornamental Products

A metal coating process which is capable of being applied to ornamental products, such as statues, sundials, garden ornaments, etc., which can be sprayed in a very short time with bronze or other metal, to give a pleasing result, has recently been put on the market. By means of a small, simple apparatus shown in Figs. 1 and 2, a thin coating of molten metal is sprayed over the concrete surface without heating or injuring that surface. The process is known as the Schoop process, and the spraying device is called a pistol.

The new process, which is entirely different from the two metal-coating processes in most extensive use—electro-plating and dipping—consists of reducing metal wire to an impalable condition by means of an oxy-hydrogen flame and then forcing these metallic particles with great velocity against the surface of the object to be coated. The particles then embed themselves in the surface of the piece to be plated and homogeneously unite with the succeeding particles that are projected upon them. The result is an even coating of deposited metal adhering to the coated object. The spraying is done by the special torch or pistol shown in Fig. 2, the wire being fed into the pistol from one side and emerging at the torch end in a fine spray. By means of this process, it is possible to coat not only ornamental concrete products, but other substances, such as wood, paper, cloth, stone, etc., with lead, tin, zinc, aluminum, copper, brass, bronze, German silver, gold and even steel. It is claimed to be the only method known of plating with aluminum and steel. Tanks of commercial hydrogen and oxygen with reducing volumes and a supply of compressed air are the only requisites for operating the pistol on any metal in the form of wire.

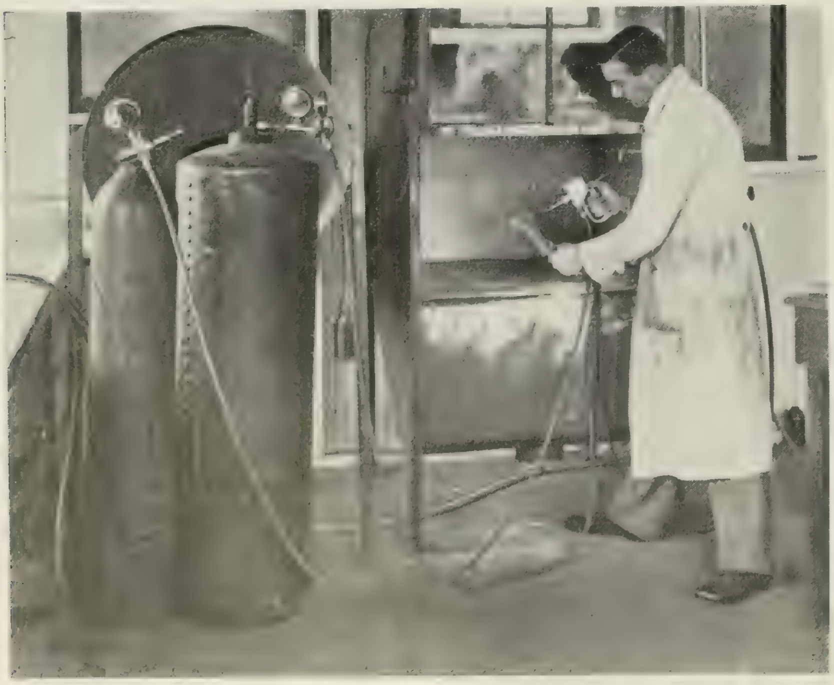


Fig. 1—Complete Outfit Consisting of Pistol and Tanks for Operating the Schoop Metal Spraying Process

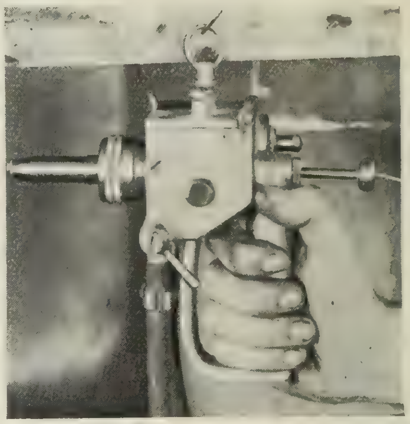


Fig. 2—View Showing Pistol Complete for Service, Used in the Schoop Metal Spraying Process

The Metals Coating Co. of America, 122 So. Michigan Ave., Chicago, controls the rights of this process in America. This concern issues licenses for the use of the process and leases the spraying pistols.

Star Drilling Machinery—The Star Drilling Machine Co., Akron, Ohio, paper, 9¾" x 7¼", 108 pp., illust. This well illustrated catalog takes up in a comprehensive manner Star portable drilling machines, engines, jars, bits, drilling and fishing tools. Detailed specifications are given, as well as price lists. The catalog is bound in lose-leaf form, neatly arranged and thoroughly indexed.

Concrete-
Cement Age

Vol. 6 *Detroit, February, 1915* *No. 2*

The Cement Show

"GETTING Together" was the caption over a paragraph on this page one year ago. It had to do with the Cement Show. There is very little more to be said now than was said then. In *getting together* lies the spirit of progress. For one man, or one set of men, or men in a single community, to feel that he or they, alone, without the rest of the world and its progress, can keep abreast of the world's progress is monstrous presumption. A prophet may live alone upon a mountain but a *doer* who is competing in skill, in price and in service with other doers of the world's work cannot afford to miss an opportunity to acquire as much as possible of the efficiency of his competitors. No better means is offered for accomplishing this thoroughly or in a short time than the Chicago Cement Show, Feb. 10-17. Meeting the thousands who will assemble at the Show and at the various conventions which aim to epitomize the year's knowledge of progress in the field will prove the right opportunity to the ambitious man.

The Fleetness of Untruth

WHEN a mis-statement starts on its travels it is hard for the truth to overtake it, and this fact is quite exemplified in articles that are appearing here and there in connection with the Edison fire. The Shenandoah, Pa., *Herald,* commenting on the fire, says:

> So "the very last word in fireproof construction" succumbed to the flames to all intents and purposes just about as completely as any old-fashioned structure would have done in similar circumstances. The "perfect example" of safety, largest of its kind and pictured as a model for the world, is found to have been a fire-trap.

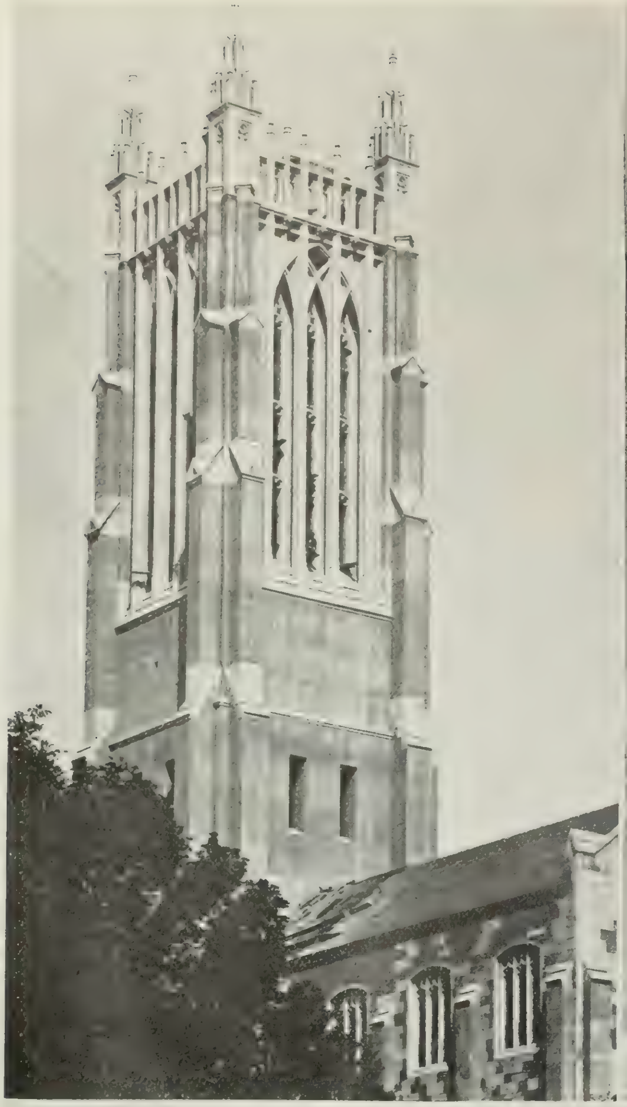
And all this without awaiting the investigation of the disaster and the discovery of the real facts in the case. Take this article as it stands and compare it with the clear, cold statements made by engineers and the scientific papers after the real investigation into the fire and see how far it is from the truth, and then think how long it will be before the actual scientific truth will ever overtake these columns of mis-statements which are doubtless being read by uninformed readers in all parts of the country.

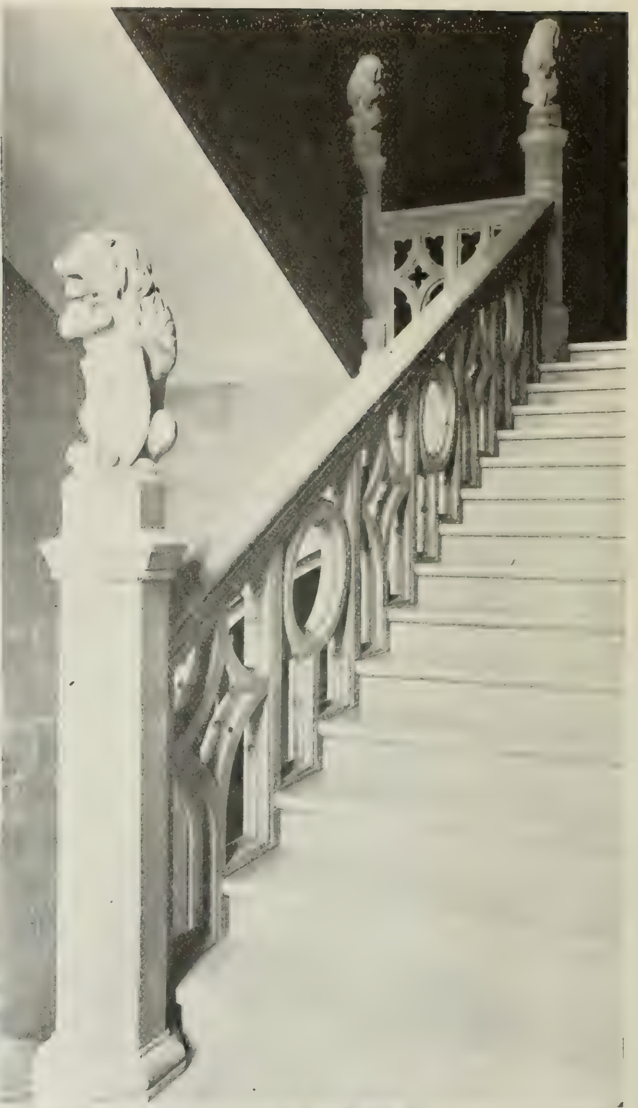
The "Block Business"

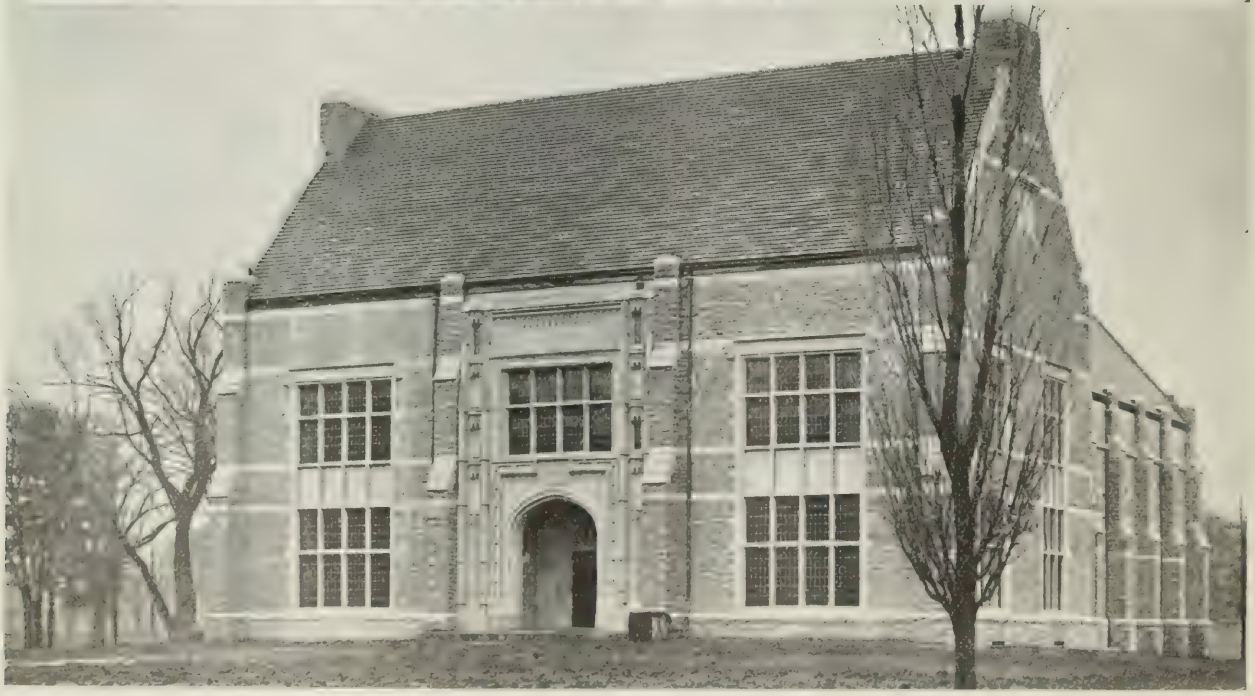
IT is an unpleasant commentary on the "block business" when a manufacturer of a new wall unit introduces it to architects with the words: "I am not offering you a concrete block." This "talking point" is mentioned elsewhere in this issue in an account of the sales methods of a structural tile manufacturer. The situation in the field of concrete building units is really not so serious as this seems to indicate. There are a great many architects using factory-made building units of concrete and finding them suitable in every way, not only to structural but to architectural requirements. The tile manufacturer is merely taking advantage of the architects' familiarity with a poor class of units—and this is another way of saying that the poor unit, architecturally, has been in evidence more than the good unit. Concrete stone manufacturers can get but one suggestion from such a situation—they will profit by a thorough study and a prompt adoption of methods which insure building units that meet architectural requirements. These methods are understood and used successfully by enough manufacturers in various parts of the country to warrant their more general adoption.

A Basic Building Code

OF the making of building codes there is no end. Each city seems to have its own set of experts and each one desires to make its own specifications. Out of this great trouble and great confusion have grown. When in New York some years ago a new building code was proposed political influences were wielded practically to exclude concrete and to substitute in almost every case hollow tile. This led to a bitter and prolonged fight between the representatives of the two materials of construction. The principal reason for this contest, which ended in the defeat of the proposed code, was that the establishment of the standard in the great metropolis of New York would have a bearing on the specifications of all other cities in the country. If the present suggestions of the American Institute of Architects for the preparation of a basic building code are carried out, dangers of this kind will no longer occur.







Tower of the Perkins Institute for the Blind, Watertown, Mass. Trim of Concrete Stone Made by Emerson & Norris Co., Boston

Stairway in New Haven, Conn., Residence. Concrete Stone Made by New England Stone Co., New Haven

Hamilton College Library, Clinton, N. Y. Trim, Including Elaborate Entrance, of Concrete Stone Made by Onondaga Litholite Co., Syracuse, N. Y.

Methods and Costs in Constructing Factory Building at Houston, Texas

By Lee A. Hoynck[1]

The reinforced concrete factory building shown in Figs. 1 to 16 inclusive and described in the following article was constructed in the spring and summer of 1913 for the Texas Bag & Fibre Co. at Houston, Tex. It is located in the northeastern part of the city, and owing to its size and appearance, will probably be a landmark for that part of the city for some years.

With due regard for the purpose of manufacturing cotton and burlap bags, careful consideration was given to such features as light, column spacing for properly locating machinery and other important factors.

GENERAL DESIGN

The building is 80′ wide and 218′ long, consisting of three stories and basement. The ceiling heights are 14′, giving ample clearance for pulleys, machinery, etc.

Various systems of reinforced concrete framing were carefully considered in the preliminary designs, but the plain beam and slab construction was finally adopted as being the most convenient.

Column spacing of 12′ x 20′ was adopted; beams are 12″ x 28″, running parallel to the short side of the building; slabs vary from 6¼″ to 6¾″ thick (see Fig. 3); and spandrel beams do not drop below the bottom of the slab, thus giving a maximum area for sash.

Brick work was kept down to a minimum, owing to the usual consideration of light and also to the high cost of brick in Houston. By omitting walls, except below the sill line, and using steel sash[2], a maximum of about 65% light area was obtained for the manufacturing floor.

Live Loads—The following live loads were used for the floor and roof system in addition to the dead weight of the structure:

First floor	250 lbs. per sq. ft.
Second floor	200 lbs. per sq. ft.
Third floor	250 lbs. per sq. ft.
Roof	50 lbs. per sq. ft.

The live load of 200 lbs. per sq. ft. for the second floor provided for manufactured goods and machinery, which gave a lower loading than for raw material to be stored on the first and third floors.

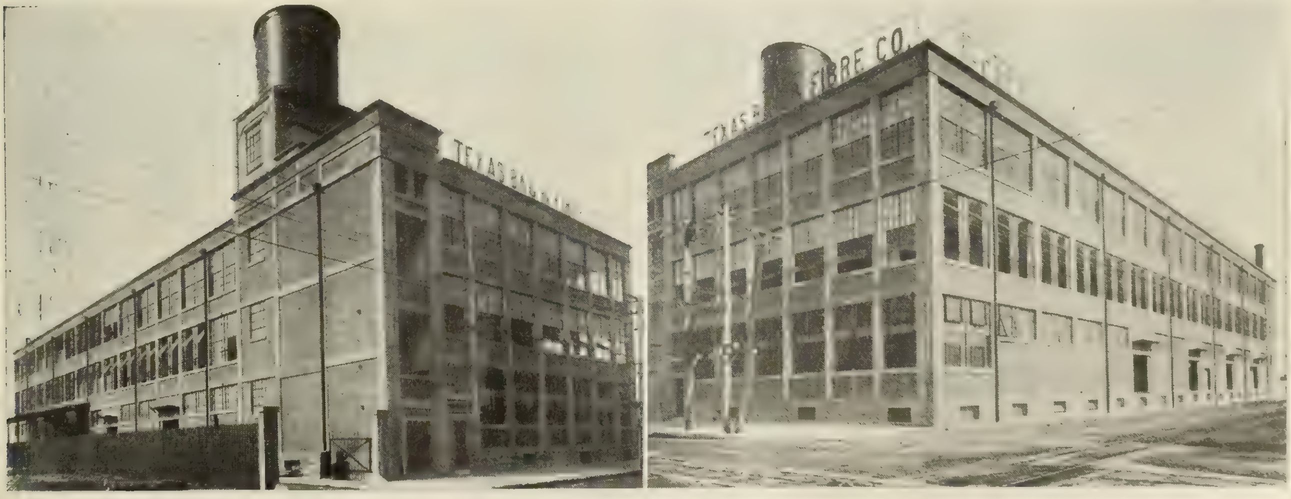
The somewhat unusual live load for Southern latitudes, 50 lbs. per sq. ft., used in designing the roof system, provides for drying damp bags in the sun.

Unit Stresses—The following unit stresses were used in the design: An allowance of 16,000 lbs. per sq. in. in tension was made for the steel reinforcement. The extreme fibre stress allowed in the concrete was 650 lbs. per sq. in. in compression, and no account was taken of tensile resistance. The direct compressive stress allowed in the concrete was 500 lbs. per sq. in. The shear taken by the concrete was assumed at 60 lbs. per sq. in. The ratio of modulus of elasticity of steel to concrete was assumed as 15. The allowable bond stress, concrete to steel, was taken at 120 lbs. per sq. in

The bearing on the soil was taken at 5,000 lbs. per sq. ft.

Reinforcement—The general contractor sublet the steel design to the Reinforced Concrete Co., Engrs., St. Louis, who submitted a design using square twisted bars and continuous stirrups. Standard usage was followed in spacing the bars in beams.

Flooring—One-in. maple flooring was nailed to 3-in. x 4-in. creosoted yellow pine screeds, which were cast in the slab. The concrete was kept to within ⅜″ from the top of the screeds as shown in Fig. 3. In arriving at the slab thicknesses, the area lost by the screeds was compensated for by adding an equivalent amount to the slab thickness. While this is only approximately correct, it was considered permissible.



Figs. 1 and 2—Front and Track-Side Views of the Texas Bag & Fibre Co.'s Factory Building at Houston, Texas

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[1] St. Louis, Mo.

[2] Furnished by the Trussed Concrete Steel Co., Youngstown, Ohio

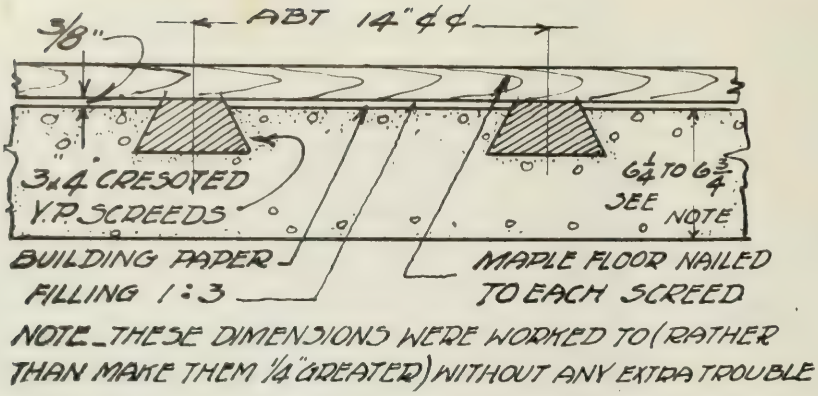


Fig. 3—Sketch Showing Method of Fastening Screeds to Concrete Floor

Concrete Fence—A concrete fence extends about 80′ along the track side of the building shown in Fig. 2 and the same distance across the lot. It is 9′ high as shown in Fig. 4. In order to obtain a pleasing architectural effect, half-round wooden strips about ¾″ in diameter were placed horizontally and vertically in the forms, to imitate stone work.

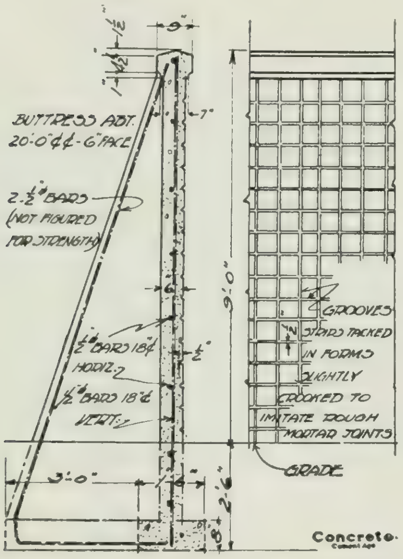


Fig. 4—Details of Reinforced Concrete Fence

MATERIALS OF CONSTRUCTION

Lone Star Portland Cement[3] was used throughout the building. It passed the requirements of the Am. Soc. for Test. Mat. The total quantity of cement used was about 5,000 bbls.

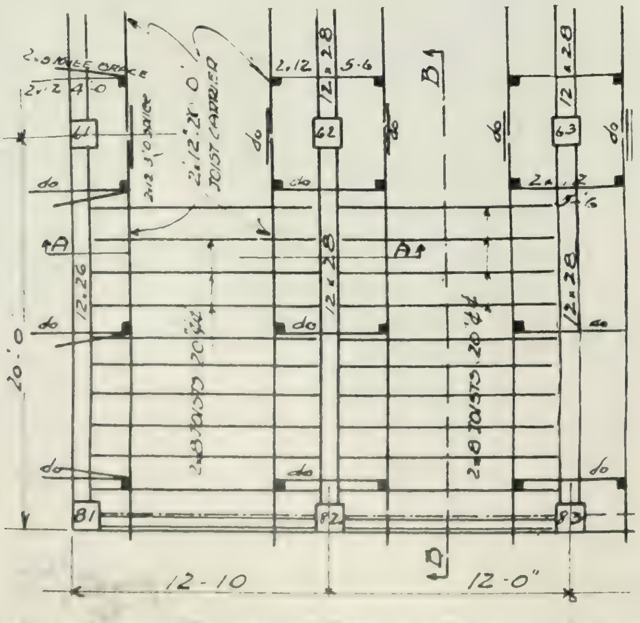
The aggregate was bank-run gravel from local pits, which varied so greatly in size that it was practically a graded mixture. Stone concrete had been decided upon but owing to the great scarcity and consequent high price of crushed stone (about $3.00 per cu. yd.) gravel was substituted, costing about $2.50 per cu. yd. delivered on the job. Owing to the large amount of foreign matter in the gravel it was washed.

EXCAVATION WORK

The building site was once occupied by a mill, but in a fire some years previous the mill was destroyed and nothing remained but the brick foundation. The contract for the excavation was let at a unit price of 50 cts. per cu. yd., but owing to the good condition of the brick foundation this proved quite financially disastrous for the contractor. Considerable blasting had to be done and some oil-soaked spots had to be cut out to a depth of 10′.

CONTINUOUS SYSTEM OF CENTERING

The centering used was that known as the Continuous system, patented



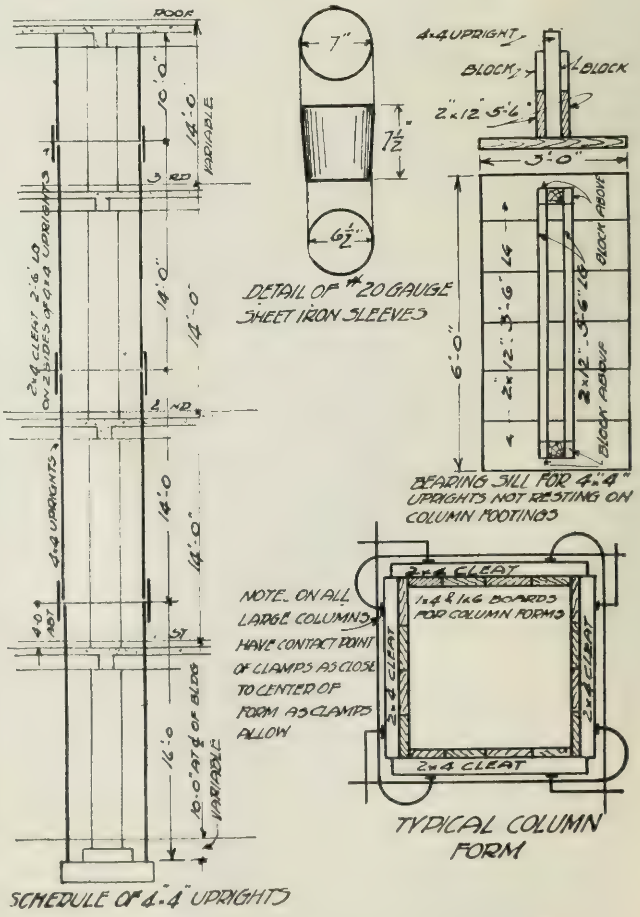


Fig. 5 Plan of "Continuous" System of Centering, Showing Joist Carriers, Etc.

Fig. 6—Schedule of 4-in. x 4-in. Uprights, Sheet Iron Sleeves, Bearing Sill and Typical Column Form

by the Reinforced Concrete Construction Co., St. Louis. In this system four upright posts, usually 4″ x 4″ in size, are set on the footing, one at each corner, "straddler beams" being nailed around them at the top to carry the floor beams, which in turn carry the slab forms, as shown in Figs. 5 to 10 inclusive. These posts extend through the floor and may be carried up independent of the concrete frame work. Fig. 6 shows a bearing sill for uprights when not resting on column footings, while Fig. 10 shows how the "straddlers" were assembled.

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[3] Texas Portland Cement Co., Dallas, Tex.

In using this system it is necessary that sleeves, preferably metal, be set around each post hole at the top of the slab forms in order to prevent wet concrete from running through the hole to the floor below. A tapered sleeve of No. 20-ga. sheet iron was used as shown in Fig. 6. It was found that this gauge of metal was too thin to withstand satisfactorily the pressure of the concrete, thus causing the sleeve to crush against the sides of the post and involving considerable labor in removing the posts later, and also in removing the sleeves. This point is worthy of consideration in any case.

After the posts were withdrawn, it was necessary to patch up the holes. This was found to be somewhat troublesome to do well, especially after the forms had been used several times and had warped to some extent. In some instances it was necessary to do considerable chipping, which is quite expensive when done by hand.

All forms for the concrete work were made of wood and were designed for the load they were expected to bear and nothing was left to guess work.

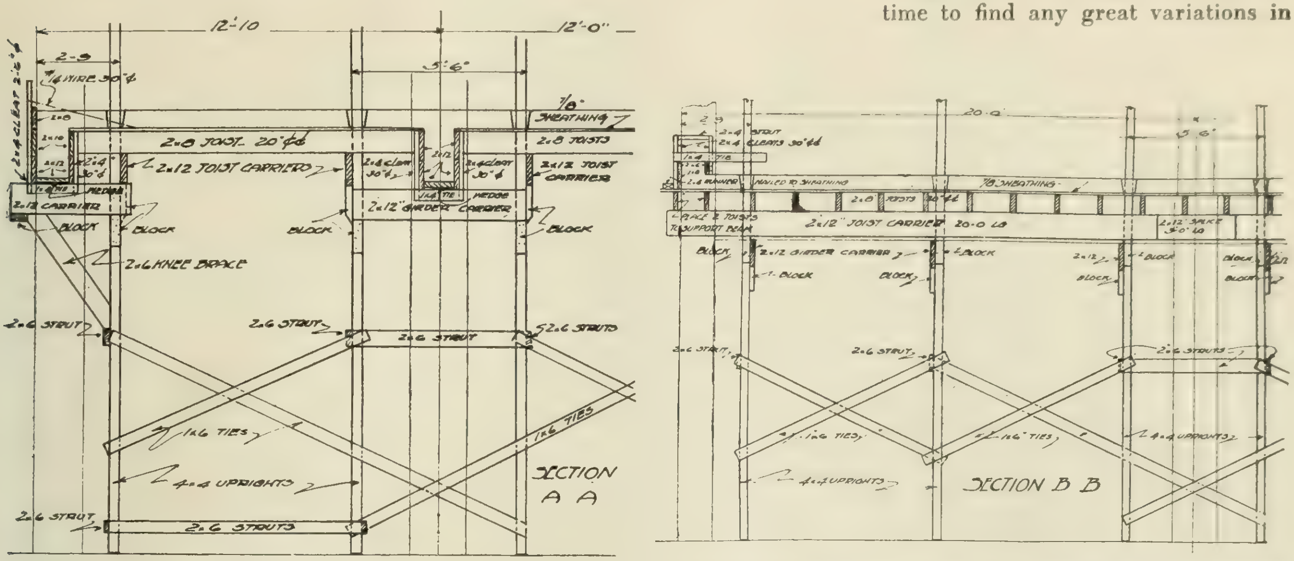
Fig. 6 shows a typical column form, made of 1-in. x 4-in. and 1-in. x 6-in. boards fastened together in panel units by means of 2-in. x 4-in. cleats. The units were assembled with iron clamps.

Form lumber cost from $20 to $25, depending on size and grade, and was used at least twice. Large quantities of it were sold for $2.00 to $4.00 per one-horse wagon load.

CONCRETE WORK

Proportions — The mix specified was a 1:6. The different proportions of sand and gravel used depended upon the quantities giving maximum density. These quantities were determined by more or less crude methods and the results obtained showed that the usual 1:2:4 mix with 40% voids was practically correct, although tests were made from time to time to find any great variations in the gravel. A good, hard concrete was obtained throughout.

Tests to determine the approximate percentage of voids in the gravel were made as follows: A vessel of known capacity was filled to the top with gravel and then enough water poured in to bring it level with the



Figs. 7 and 8—Sections "AA" and "BB" Showing Elevation of Continuous Centering. See Fig. 5 for Location of Section Line

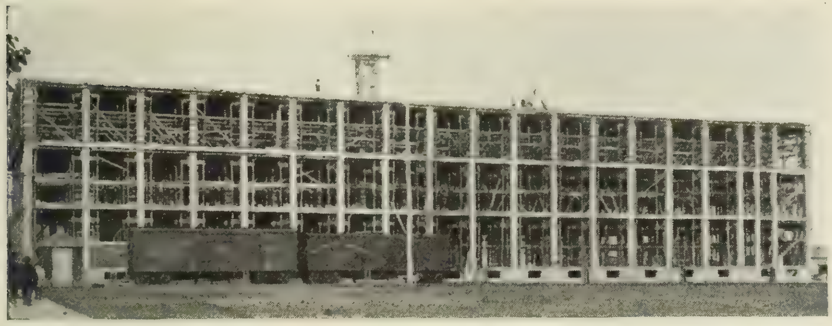


Fig. 9—Track-Side Elevation, Showing Continuous System of Centering

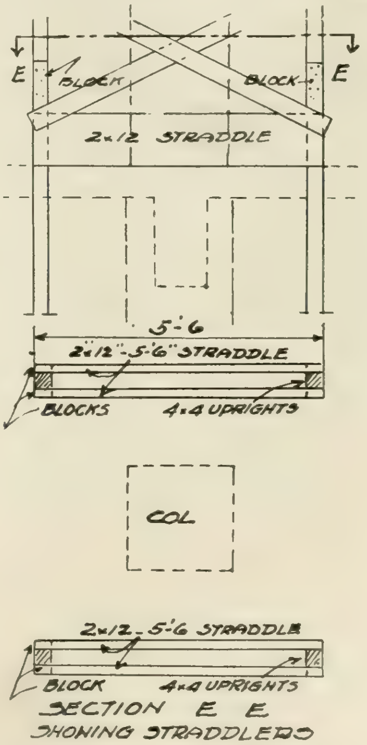


Fig. 10—Sketch Showing Method of Using 2-in. x 12-in. "Straddles" in Connection With 4-in. x 4-in. Uprights

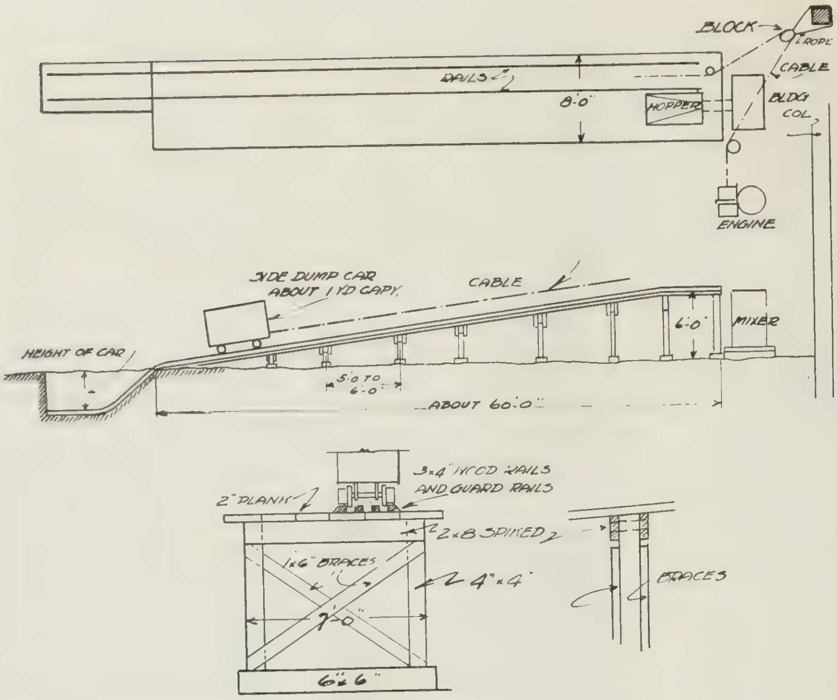


Fig. 11—Sketch Showing Layout of Concrete Mixing Plant

top. The water was then poured off, and its volume measured. With the void percentage known the proper mixture was taken directly from standard tables, and the results were quite gratifying. It should be noted that tests of this sort are open to criticism since they are only approximately correct, but the size of the job hardly justified more elaborate tests.

Mixing—The concrete for the whole building was mixed in a two-yard Ransome batch mixer[4], which was set on grade, and a wooden incline was built about 6′ high reaching to the material pile, as shown in Fig. 11. This method worked quite well in the spring, but when hot weather came the laborers, who were mostly negroes, became tired out early in the day, with the result that the proper quantity of sand and gravel was not realized. To overcome this difficulty, a dump cart was rigged up with a hoisting engine, as shown in Fig. 11, rails of 3-in. x 4-in. sticks were fastened to the incline, as well as guard rails of the same size. This method of conveying materials to the mixer resulted in some lower labor costs.

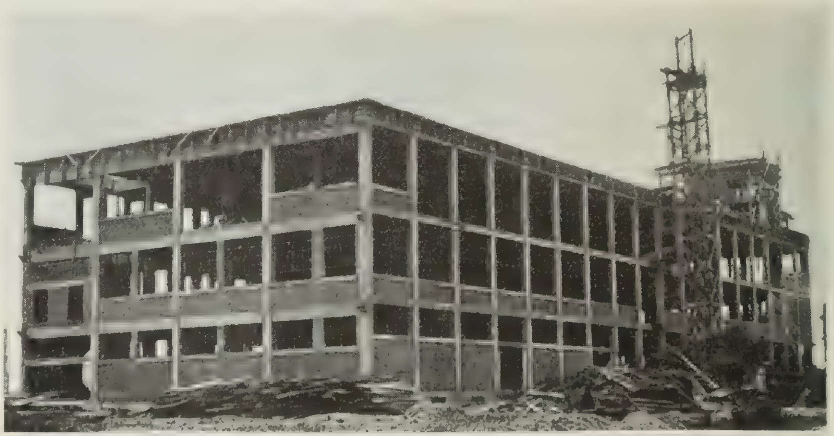
Conveyors—A chute with steel A-frame fastened to the tower, shown in Figs. 12 and 13, was tried out, but found unsatisfactory as it became badly bent from an overdose of material which was sent there by accident. This resulted in wrecking a section of the chute. It was impossible at this time to make any repairs and a number of hand carts were immediately procured and used with such good results that the chute was abandoned at a complete loss. The structural weakness of this chute was observed at the beginning of the work, and an effort was made to strengthen it by means of hog-chains, but this proved of little use. It was also found awkward to move the chute around, owing to the extreme length of the building. This objection, however, did not cause the abandonment, but its inadaptability to the work.

GENERAL FEATURES

Concrete Window Sills—The concrete window sills were about 7″ x 11″ in cross-section and were cast in two parts, each about 5′ 9″ long. One-quarter in. round bars were placed in each corner for the purpose of handling without breakage (see Fig. 14). Six sills were cast each day. The forms were lined with No. 16-ga. galvanized iron. They were made to accommodate the longest sills and partitioned off for the shorter sills.

Proper attention was given to curing the sills. It was found unnecessary to treat the surfaces in any way as they were as smooth as cut stone and had the appearance of this material.

Machinery Bolts—In setting bolts



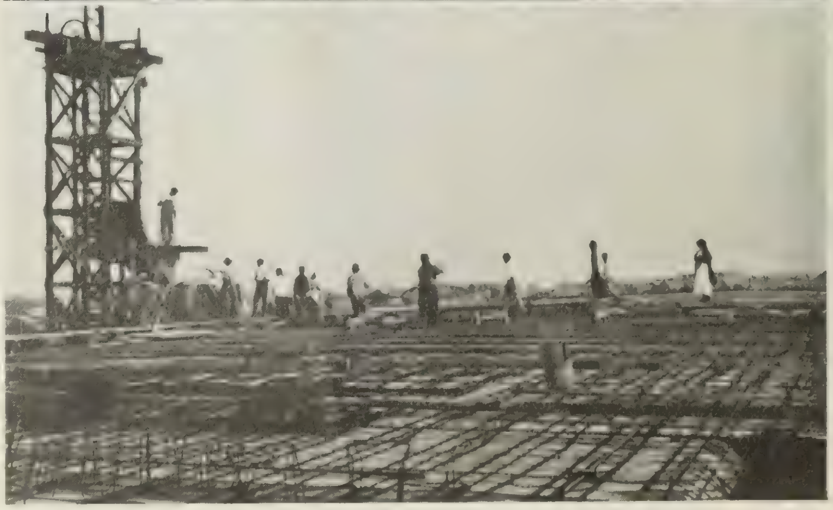


Fig. 12—Rear View of Building Showing Concrete Hoisting Tower
Fig. 13—Method of Conveying Concrete

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[4] Ransome Concrete Machinery Co., Dunellen, N. J.

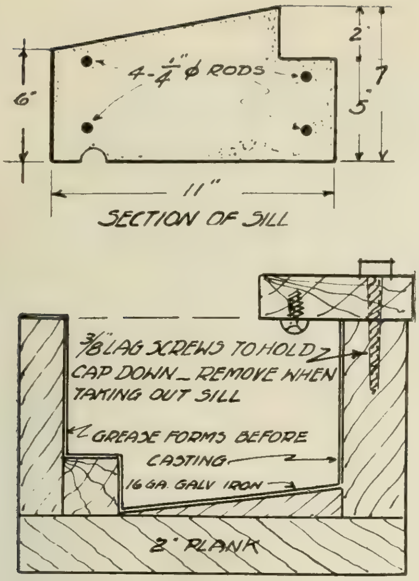

4-¼" ∅ RODS
6"
2"
7
5
11"
SECTION OF SILL
⅜ LAG SCREWS TO HOLD CAP DOWN _ REMOVE WHEN TAKING OUT SILL
GREASE FORMS BEFORE CASTING
16 GA. GALV IRON
2" PLANK

Fig. 14—Section Showing Concrete Window Sill and Forms Used in Casting

used in fastening the machinery a very simple device was used, as shown in Fig. 15. The cost of these sheet metal stands was negligible and little time was required in setting them, while the bolts were accurately set in place.

Placing Screeds—In placing the floor screeds 2-in. x 6-in. planks were nailed to the extending uprights used in the continuous system of centering previously described, and the screeds were hung from these by heavy wires, as shown in Fig. 16. This method proved to be very convenient. At first it was intended to place the screeds on wooden blocks, but at the suggestion of the carpenter foreman the wiring was substituted, with much better results.

Cost Data—At the start of the form work an attempt was made to get unit costs at the end of each day's work, but owing to the size of the job this was found somewhat difficult to carry out, since it required considerable time each day to check up the different parts of the work done. The main difficulty encountered seemed to be the reduction of such items as centering, etc., into equivalent sq. ft. of form work in contact. It is possible on high buildings to predict this quite closely after one or two floors have been framed; on low buildings it is not very easy.

The writer believes that on jobs of considerable size it is possible to determine what is the most economical number of men to be used for doing a certain work by plotting results from each day's work, using men-hours and unit costs per sq. ft. as co-ordinates. There are so many variables involved that results change from day to day, but still it may prove valuable. To the writer's knowledge this has not been done up to this time.

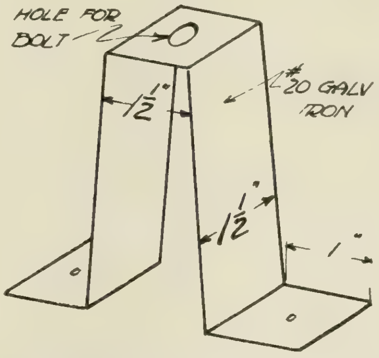


Fig. 15—Sheet Metal Stand Used for Holding Machinery Bolts in Place While Concreting

With cement at $1.58 per bbl., sand $1.00 per cu. yd., gravel at $2.50 per cu. yd. and labor at 22 cts. per hr., the following unit costs were obtained:

Walls and footings $5.50 per cu. yd., using a 1:2½:5 mix.

Floors, beams and columns $8.25 per cu. yd. using a 1:2:4 mix.

The above items include time for engine man and fireman.

With carpenters' wages at $4.50 per da., forms cost 11 cts. per sq. ft.; the placing of steel cost $8.00 per ton, while the steel cost $50 per ton, f. o. b. Houston.

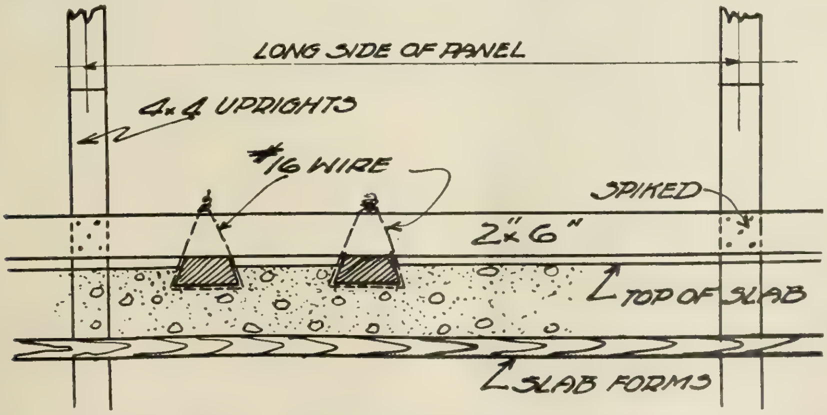


Fig. 16—Sketch Showing Method of Holding Screeds in Place While Concreting

PERSONNEL

The planning and erection of this factory building were done under the direction of the Texas Bag & Fibre Co.'s engineers. Much credit is due C. D. Whitmire, the superintendent for the James Black Masonry & Contracting Co., St. Louis, for the successful completion of the work. The writer assisted in preparing the plans, checking the steel design and acting as the engineer's representative on the job.

Concrete in Mine Shafts

The present decade marks many new uses for cement and none more important than in mines and mining operations. At the 60th general meeting of the Institution of Mining Engs. held recently in London an interesting paper was read dealing with the sinking and equipment of a large coal mine in the Durham district in England.

An interesting feature about the work was the use of liquid concrete for stopping the flow of water in the limestone. The water in the north shaft was allowed to rise to its natural level, 186′ from the surface and 259′ from the bottom. From a temporary platform at water level eight columns of 3-in. pipes were run down to the bottom of the shaft, and a column of 15-in. air pipes was suspended in the center of the shaft. Down the latter about 150 tons of 1½-in. broken slag were passed, which formed a conical mass at the bottom surrounding the 3-in. pipes. Down these 100 tons of liquid concrete were then run through the slag, the result being to form a cement-concrete plug about 15 ft. thick on the shaft bottom. A month later, the water having been pumped out to the level on the top of the plug, the concrete was drilled out of the 3-in. pipes and the holes continued 30′ down into the strata below. Liquid concrete was then forced down these holes by a concrete pump at a maximum pressure of 700 lbs. per sq. in., so as to fill the open fissures in the strata. In this way the feeders were reduced to quite a negligible quantity.

Where weight is not desired cells may be introduced in ordinary mass concrete, formed either by cheap hemlock boxes, which can be left in the work, or by collapsible boxes, which can be withdrawn and used over again. Where weight is desirable large stones can be rammed in the heart of the mass.

Layout, Operation and Selling Methods of a Structual Tile Manufactory

By Harvey Whipple

A very promising business in the manufacture of a small concrete unit, to compete with common brick and clay tile in wall construction, has been built up in the last few months by the Delta Brick & Tile Co., Detroit. The chief feature of the entire enterprise, not only from the manufacturing but from the sales standpoint, is its simplicity. With very few minor exceptions there is but one set of factory operations with but one kind and grade of materials used, and there being but one type of product to sell, a strong campaign along one single line has served to put the product on the market. The factory is simple in layout and in equipment, yet this very simplicity, as it has been carefully worked out, develops a higher degree of efficiency than is met with in the general run of concrete products factories. Not only is the enterprise simple in its physical make-up but it is simple in its line of business and as already mentioned, simple in its sales methods. It is, as shown by excellent evidence, making money.

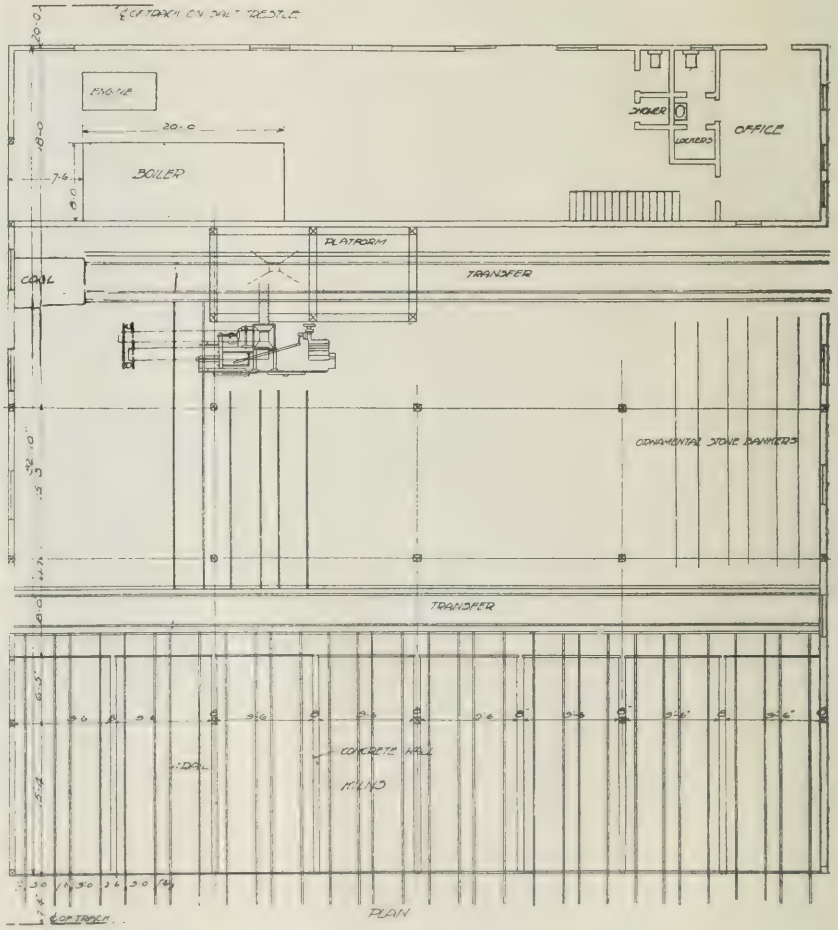
Under the management of S. H. Wightman the company began in the summer of 1914 the manufacture of structural tile with the Eberling machine.[1]

GENERAL FEATURES

Location—The company owns a rather large tract of land with 1,800′ of water front, so that materials can be delivered by boat at a low freight rate. In addition, the factory is at the end of the Detroit Belt Line Ry., so there is a good rail connection for receiving other raw materials and also for the shipment of the factory products to distant points in the outlying districts of the city.

Building—The building is approximately 82′ x 32′ in plan, open to the turret roof in the center, with a balcony on each side at the second floor level.

Equipment and Layout—The principal item of equipment is the tile machine located as shown on the floor



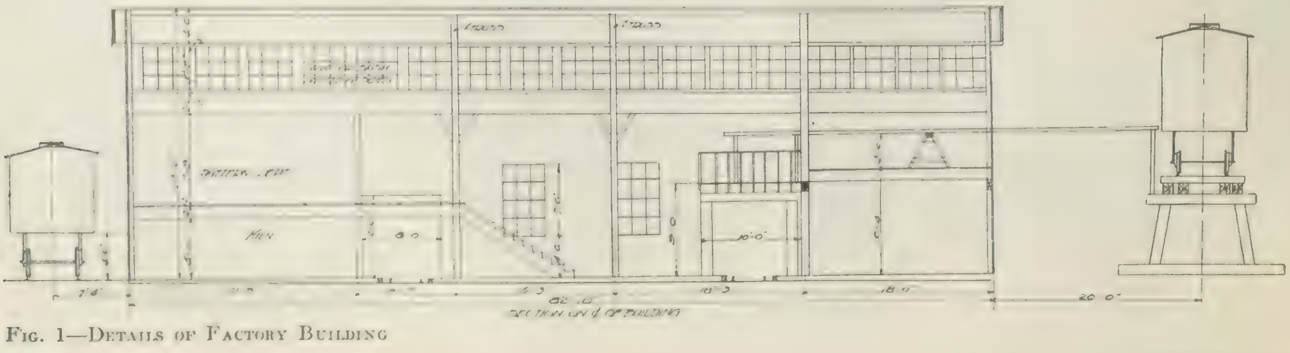


Fig. 1—Details of Factory Building

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[1] Eberling Cement Machinery Co., Cleveland, Ohio

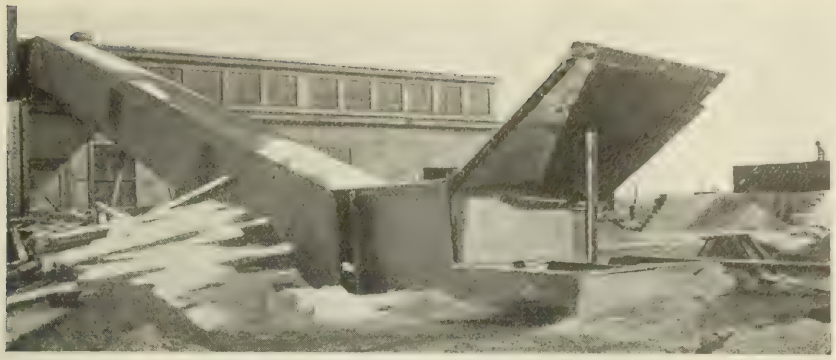

Fig. 2—Hopper and Enclosure for Belt Conveyor Carrying Sand and Stone to Top of Plant

plan on the first floor level immediately under the edge of the balcony on which the cement is received, where the mixer stands and to which level the aggregates are elevated by a belt conveyor from the stock piles in the yard. In front of this machine, at the off-bearing end, are two tracks for cars receiving tile, and across the room with a transfer track in front are the inner ends of the curing rooms which are under the balcony on the opposite side from the machine. In the front half of the main part of the building between the transfer track and the office is a space fitted out with bankers on which special filler units are made in wood molds and on which trim stone is turned out, if required. This, however, is not a feature of the factory output. The space on the balcony over the steam curing rooms is used as a pattern department and for storage space for miscellaneous items of equipment. This level is reached by a stairway which bridges the transfer track.

The Product—The product manufactured is a hollow concrete tile, the basic unit of which is 5″ x 4″ x 12″, the exposed face of which, as laid up in the wall, is 5″ x 12″. With a slight adjustment, the machine will make any of the following combinations of this unit: four tile, 5″ x 4″ x 12″; two tile, 5″ x 8″ x 12″; one tile 5″ x 4″ x 12″ and one tile 5″ x 12″ x 12″ or one tile 5″ x 16″ x 12″. The thickness of the tile walls is about 1″. The machine has a capacity of 14,400 units 5″ x 4″ x 12″ per da. However, the principal unit used in building is 5″ x 8″ x 12″ and with these, the capacity is 7,200 units per da. This unit is equal approximately to 6.4 common brick—therefore, the capacity of the machine is equivalent to 46,000 brick per da. In addition to these units made on the machine the factory turns out special units in wood molds for quoins and fillers as each job requires, keeping a stock of the sizes most frequently used. An output of so limited a range and yet suited to practically all building requirements has distinctive advantages from a stock standpoint, and Mr. Wightman compares it with the stock which he once kept on hand in a concrete block plant where he said he had in his yard 288 different concrete units. This tile unit works out very well from a building standpoint, inasmuch as it does not require of the architect that he figure his plans any differently from what he would for common brick. In fact, many jobs have been taken which were already figured for brick. As placed in the wall the unit is two brick high, the brick being 2⅜″ thick, and allowing for ¼″ mortar joint, this gives one tile height. Clay tile, on the other hand, are about 4¾″ high.

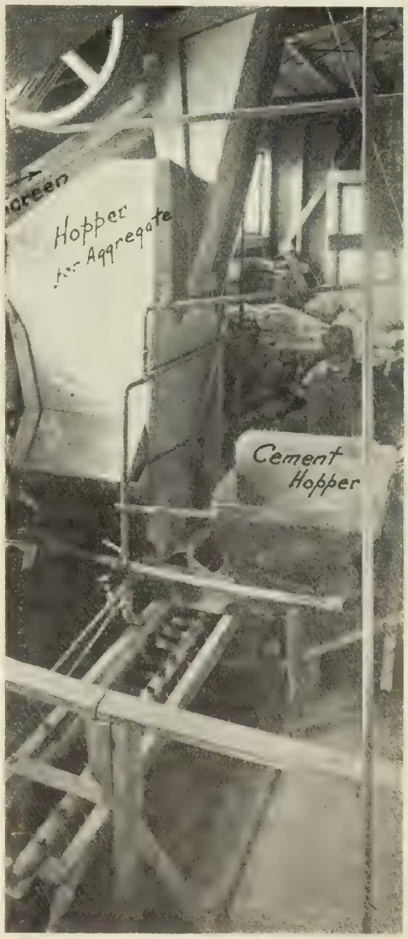

Fig. 3—Discharge End of Belt Conveyor on to Screen, Showing Hoppers and Mixers on Second Floor

Materials—A great deal of experimenting was done before the materials of which tile were to be made were decided upon. Trial mixtures were made from two different supplies of slag for coarse aggregate, from three or four different supplies of crushed stone, and with several mixtures of gravel. It was finally decided, however, to use a mixture of washed dolomite screenings, ¼″ to ½″, with sand in which particles up to ½″ are retained. The mixture ordinarily used is approximately 1 cement to 2 of the sand to 2¼ of the screenings. Each new shipment of material undergoes sieve analysis and also experiment by trial mixture to determine the proportions to be used. The mixture which is used is giving a product of good density and strength. While the unit manufactured is probably more nearly impervious to moisture than the average concrete block, imperviousness is not considered so important as in construction with another type of unit, because the tile, laid up as they are in walls, do not permit the passage of moisture from the outside to the inside, due to the large amount of air space as considered in connection with the angle of absorption through a perpendicular wall.

OPERATION

Unloading Materials—Sand comes to the factory by boat. This gives an advantage in freight rate and in the cost of sand itself aside from freight, so that the purchase price is 40 cts. per cu. yd. It is unloaded by clamshell bucket in a pile at the rear of the factory property. When sand comes in by boat it gives the user the additional advantage of a greater quantity of material per cu. yd. This difference is great enough so that 10 carloads of sand by boat make 11 cars when re-handled for rail shipment. The user of sand by boat thus has a 10% advantage.

Further, the additional cost of unloading sand by rail would be approximately 15 cts. per cu. yd. The screenings cost 50 cts. per cu. yd. (35 cts. for material and 15 cts. for freight) coming by rail and the cost of unloading and wheeling to the conveyor hopper is 15 cts. per cu. yd. A car of stone is delivered on the company's siding, and floating labor is employed in unloading it. It is wheeled out of the car and dumped from a runway built up to car height into a pile from which it can be han-

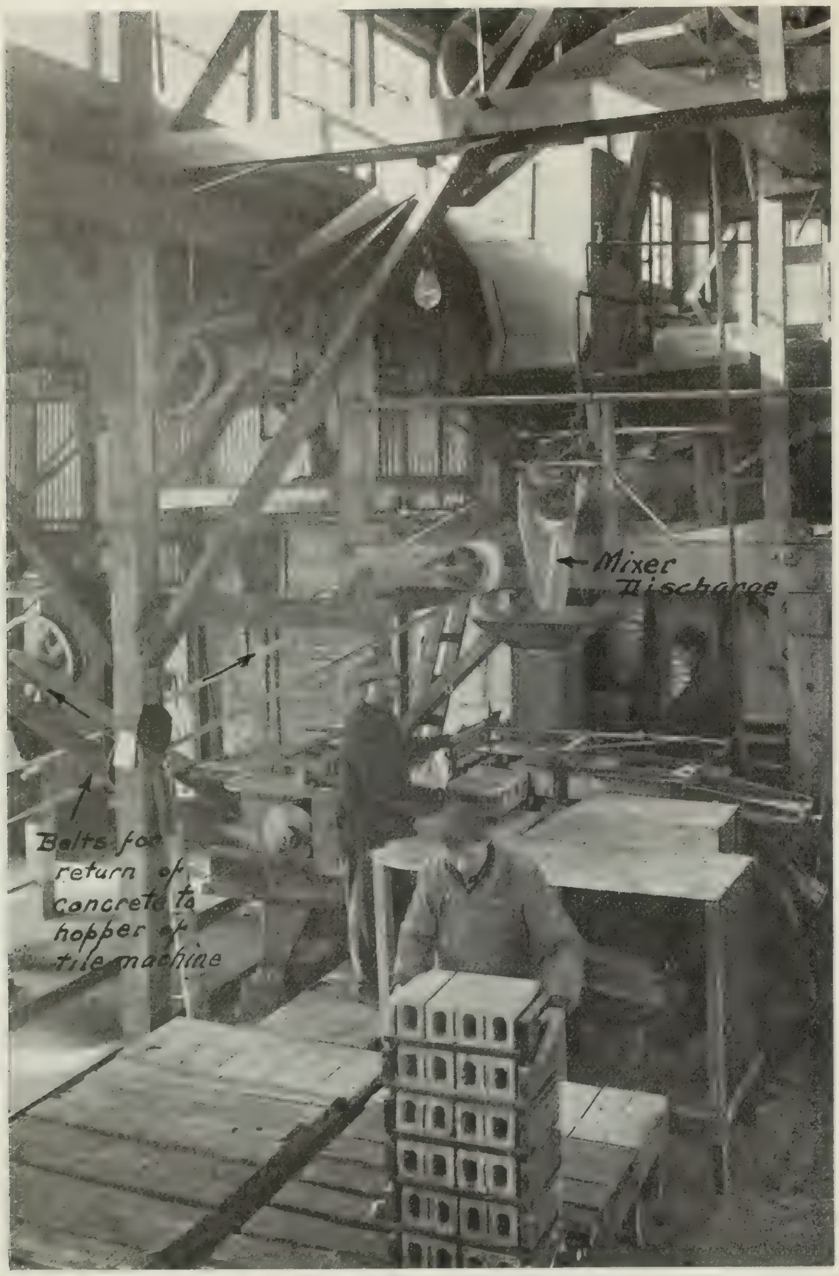

Fig. 4—Showing Hopper Above Second Floor, Mixer on Second Floor and Tile Machine First Floor, with Belt Conveyor Returning Concrete Off-Fall Back to Hopper of Tile Machine

dled conveniently a second time into the hopper of the conveyor. Cement is received in car lots in bags, the siding being on a trestle outside of the factory on which the mixer stands. This trestle is high enough to bring the car door 4′ above the second floor of the factory. There is a runway from this door to the car door and the cement is unloaded on to a four-wheeled Reynolds[2] truck, about 30 bags to the load, and shoved into the factory, and piled up at this second story level. The distance covered with this push truck is about 30′. The height of the truck from the floor is about 18″, a convenient height for handling bags. A car load of 230 bbls. is unloaded and piled in the factory at a labor cost of approximately $1.00.

Conveying and Mixing—The accompanying detail drawings show both the outside hopper end and the inside delivering end of the conveying, mixing and molding equipment. The outside hopper is a concrete box sunk into the ground so that the top of it is about 1′ above grade. The belt conveyor, consisting of a 200-ft. length of 14-in. Leviathan canvas belt,[3] operates from the hopper outside to an elevation near the top of the second story level of the factory. The feed of the materials to the belt is controlled, as shown in the details, by adjustable gears which operate two worms, one each in the two compartments of the hopper, the discharge end of one worm being slightly in advance of the other in the plan. When a proportion of screenings to sand is decided upon the gears controlling this feed are adjusted for this proportion. Then all the laborer has to do at the hopper end of this conveyor equipment is to keep the hopper on each side filled with material—sand on one side and screenings on the other—and to loosen up the material occasionally in case it becomes clogged. This hopper is not far distant from the engine room and boiler of the factory and steam pipes run out into the yard near the hopper. The hopper itself is covered by a light roof to keep out the snow, but is open at the sides. In cold weather, when materials freeze up, they are thawed by the use of steam through a short length of hose and a flue blower. This is inserted into the pile and the material thawed and warmed. Materials drop on to this 14-in. belt—stone on the bottom and sand on the top—and are elevated to the top of the factory, where they fall on to a shaking screen. This screen eliminates over-size particles, the quantity of which is very small. A small metal plate fastened on the top of the screen, at a point where the stream of materials strikes the screen, breaks the fall of nails or other similar objects which might clog the mixing machinery, and they are eliminated with the over-size particles. The screened material falls into a hopper as shown in the detail, and this feeds into a continuous mixer which is of special design to meet this particular installation. A trial of several months has indicated that the mixer maintains positive proportions and gives good results. The cement is fed into another hopper opposite the one containing the sand and screenings, and the man who handles the cement watches both material hoppers to see that the supply flows evenly. The proportion of cement to aggregate is controlled by an adjustable apparatus which cuts off a given quantity of each of the materials which fall into the trough of the mixer. The water feed is controlled by a man on the floor below who is operating the tile machine. The number of paddles in the continuous mixer is unusually large and the mixing operations apparently are carried through very thoroughly. The mixed concrete falls into the hopper of the tile machine.

Molding—The empty pallet moves under this hopper, is filled with a

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[2] Lansing Co., Lansing, Mich.

[3] Main Belting Co., Philadelphia

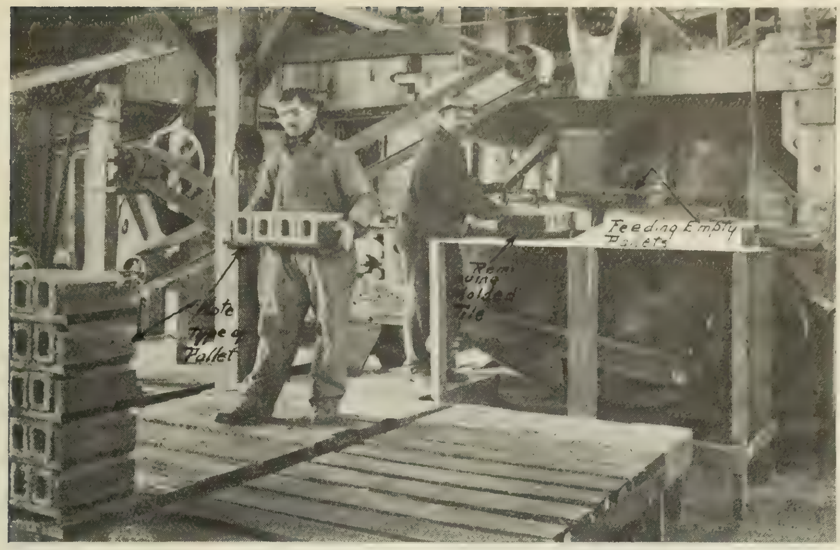

Fig. 5—A Closer, Detailed View of Tile Machine in Operation

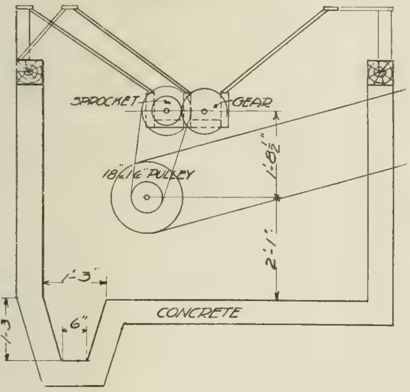

Fig. 6—Side Elevator of Outside Hopper for Conveyor

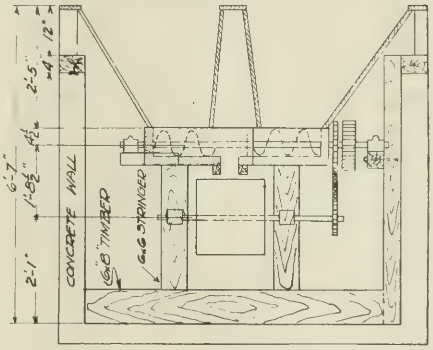

Fig. 7—End Elevation of Outside Hopper and Proportioning Apparatus

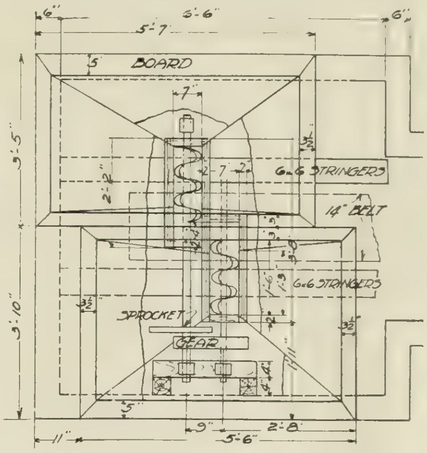

Fig. 8—Plan, Outside Hopper of Conveyor Equipment

measured quantity of mixed concrete and then moves forward in line with the knives and plungers which cut out the tile and compress the walls. It will be noticed from the accompanying illustrations that the pallets have side walls on two sides. The machine itself supplies the walls of the other two sides when the pallet is filled. When the knives and plungers are withdrawn, and the tile is molded the pallet is pulled forward on the table of the machine by the machine operator; the tile is then picked up by the off-bearer and piled up on a car. The cars are without the usual decks required in block manufacture as the construction of the pallets with the two heavy side walls makes it possible to pile one pallet on top of another, without the pallet on top touching the tile on the pallet below.

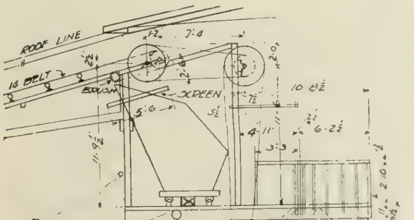

Fig. 9—Elevation of Conveying, Mixing and Molding Equipment

Note brush under belt conveyor returning; this cleans dust from belt and protects idlers

In the operation of this machine the knives and plungers which form the tile and compress the walls reject the surplus of concrete. It is necessary that each pallet which comes to the plungers and knives have a surplus of material in order to give density in the walls when the pressure is applied. This surplus material is rejected and falls through the table of the machine into a pit under the machine and onto a rubber belt[4] conveyor which is shown in the accompanying details. This belt conveyor lifts the concrete out of the pit, drops it into a chute from which it falls onto a return belt which takes it back to the hopper of the tile machine. The rubber belt is believed to be the most desirable for handling wet concrete. The mixture used in making these tile is so wet that water stands on the surface of the tile as they come from the machine.

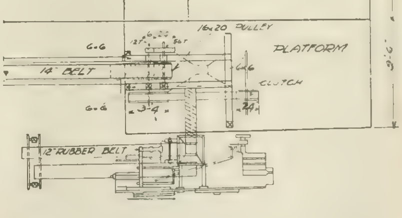

Fig. 10—Plan of Conveying, Mixing and Molding Equipment

The plant has been so laid out that more of these tile molding machines may be added in a line from the front to the back of the building. When this is done additional tracks will be put in to accommodate two cars for each machine.

Curing—A loaded car of tile is shoved into the curing rooms, which are very low with a flat roof, and heavy wood, batten doors. The steam enters through perforated pipes at 5 lbs. pressure, a reducing valve being used to keep this pressure uniform. The perforations are so placed that the steam takes a downward and outward course toward the side walls of the curing room. In this way the hot steam does not come immediately in contact with the products. Inasmuch as the unit manufactured is not a facing unit requiring special care, the drip of condensed steam from the ceiling is not considered a disadvantage.

Mr. Wightman has made some interesting tests to show the results to be obtained by prolonging the curing period beyond the ordinary 48-hr. duration, and in the near future he will erect a large building in front of

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[4] B. F. Goodrich Rubber Co., Akron, Ohio

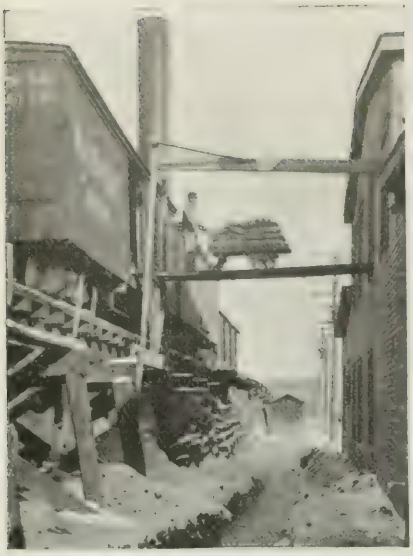

Fig. 11—Unloading Cement

the present structure, with sufficient storage space for 600,000 tile in separate rooms, each to contain 50,000 tile. It is planned then to keep the tile in the hot steam rooms where the steam is admitted at 5-lb. pressure for a period of from 24 hrs. to 48 hrs., then to take then out on cars, remove the tile from the pallets, place them on a gravity conveyor which will run under the floor of the factory building through a tunnel and into the storage building directly in front. An elevator will be used in connection with this gravity conveyor which will pick up the tile in the storage room and lift them to the top of the storage piles, where short lengths of gravity conveyors will bring them within reach of men employed in piling them. This building will be steam-heated, with moist steam. The division walls of the rooms in the storage building will be built of tile and it is expected that this arrangement, with a very small additional cost for the extra supply of steam, will effect economy in the quantity of cement used to obtain a given strength. While it is realized that a given amount of cement must be used to give density, it is nevertheless a fact that cement in excess of this quantity can frequently be used in order to obtain great strength in a short curing period. By providing better curing conditions for a long period it will be possible to economize by the elimination of this excess quantity of cement. The tests made by Mr. Wightman show that tile cured in air alone for 3 wks. had a compressive strength of 1,325 lbs. per sq. in.; tile cured in steam 24 hrs. and in air 3 wks. (as is done now) had a strength of 2,227 lbs. per sq. in. and that tile kept in the moist warm air of the steam room 3 wks.

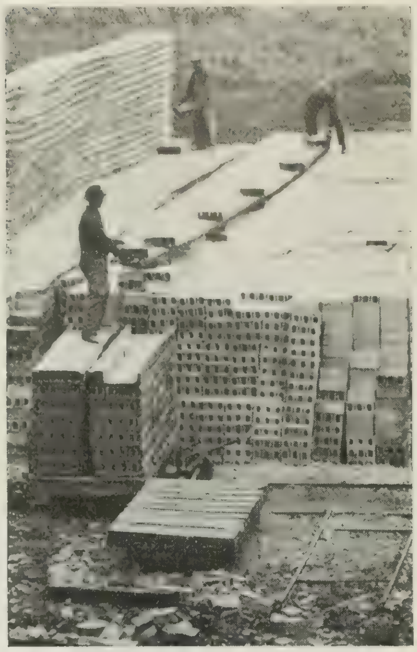

Fig. 12—Piling Tile in Yard, Using Gravity Conveyor

had a strength of 2,787 lbs. per sq. in.

Storing—As the factory is now operated, the tile are brought out of the curing rooms on cars on a transfer track and shoved into the yard, gravity carriers[5] being used in conveying tile from the car to the stock piles, one man at the loading end of the conveyor being quite enough to keep two or three men busy piling at the other end. When a pile has been brought up to a given height the pile is leveled off and the conveyor is then placed on top of this pile and the pile built up to double its height, the conveyor and men working on top of the original pile. The same equipment is used in loading freight cars. With 5 men a car containing 10,000 tile (5"x4"x12") can be loaded in this way in 1 hr. 20 min. This work is now being

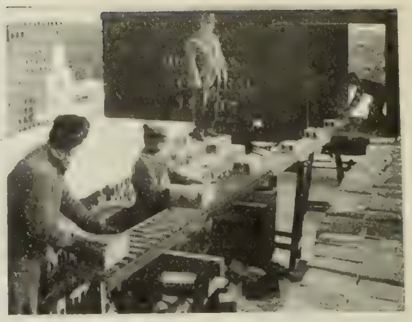

Fig. 13—Loading Tile in Car; Two Men Place Tile on Conveyor and Three Men Work in Car

An automatic counter keeps account of the number of units loaded

done on a piece work basis of 25 cts. per M tile (unit size 5" x 4" x 12") per man.

Labor—The men regularly employed in the factory and their wages are as follows:

1 man shoveling into the outside hopper, $2.00 per da.
1 man at the mixer feeding cement into the hopper, $2.00 per da.
1 foreman, also engineer, $3.25 per da.
1 man feeding pallets into the tile machine, $2.00 per da.
1 operator for machine, $2.25 per da.
1 off-bearer, $2.00 per da.
2 yard men, $1.75 per da.
4 yard men, $2.00 per da.
1 man making small filler units and trim stone, $3.00 per da.
1 man working on patterns and doing estimating, $4.00 per da.
1 nightwatchman, $2.50 per da.
1 office assistant, $3.00 per da., besides the manager of the factory.

Costs—It will be seen from the labor items that the labor cost per da., aside from the management, is $37.50. This makes no allowance for the additional labor employed when a carload of cement comes in or when a car of stone is delivered. To make 7,200 units, 5" x 8" x 12" requires 29 tons of stone at 65 cts., which is a total of $18.85; 24½ yds. sand at 40 cts., a total cost of $9.80; 70 bbls. of cement at $1.04; $72.80; making the total cost for labor and materials, not counting fuel and other small items, $138.95. The total production value in one day is about $300 (at the yard) running at capacity. That is

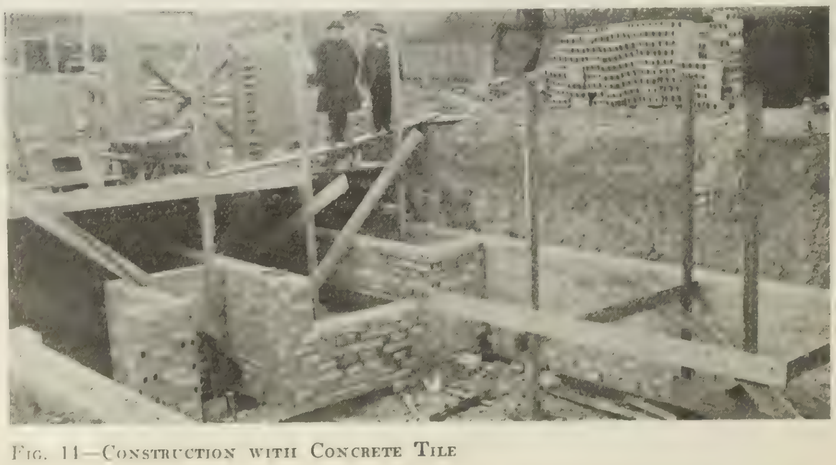

Fig. 14—Construction with Concrete Tile

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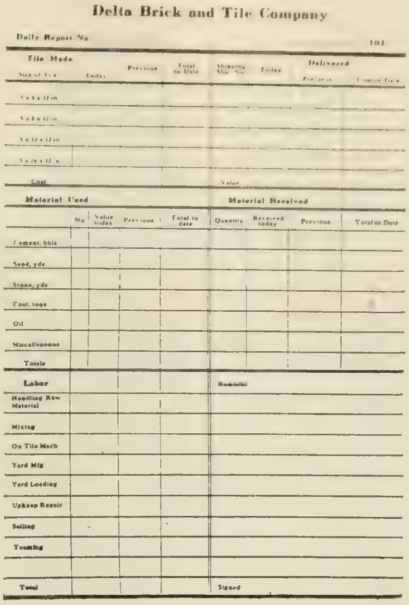
[5] Mathews Gravity Carrier Co., Ellwood City, Pa.

figured at $273.60 for tile and the balance of the total for hand-made filler units.

To deliver these tile on the job costs about $6.00 per M, of the 5-in. x 8-in. x 12-in. units. Shop records are kept as shown by the daily report and weekly report blanks which are published herewith.



Delta Brick and Tile Company

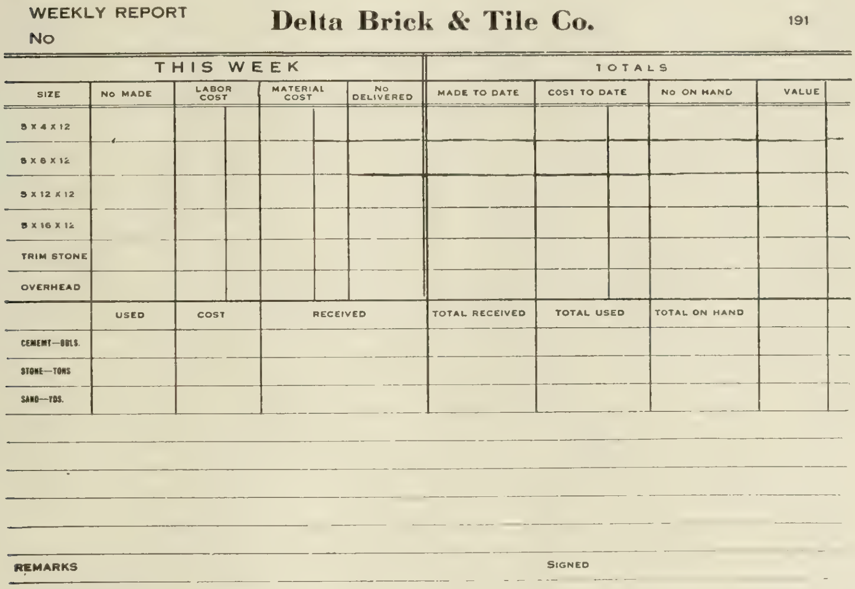
Daily Report No 191

Tile Made Size of Tile	Today	Previous	Total to Date	Shipping Slip No	Today	Delivered Previous	Total to Date
5 x 4 x 12 in							
5 x 8 x 12 in							
5 x 12 x 12 in							
5 x 16 x 12 in							
Cost				Value			

Material Used	No	Value today	Previous	Total to date	Material Received Quantity	Received today	Previous	Total to Date
Cement, bbls								
Sand, yds								
Stone, yds								
Coal, tons								
Oil								
Miscellaneous								
Totals								

Labor				Remarks
Handling Raw Material				
Mixing				
On Tile Mach				
Yard Mfg				
Yard Loading				
Upkeep Repair				
Selling				
Teaming				
Total				Signed

Fig. 15—Blank Used in Keeping Daily Account



WEEKLY REPORT
No

Delta Brick & Tile Co. 191

THIS WEEK					TOTALS			
SIZE	NO MADE	LABOR COST	MATERIAL COST	NO DELIVERED	MADE TO DATE	COST TO DATE	NO ON HAND	VALUE
5 X 4 X 12								
5 X 8 X 12								
5 X 12 X 12								
5 X 16 X 12								
TRIM STONE								
OVERHEAD								

	USED	COST	RECEIVED	TOTAL RECEIVED	TOTAL USED	TOTAL ON HAND
CEMENT—BBLS.						
STONE—TONS						
SAND—YDS.						

REMARKS

SIGNED

Fig. 16—Weekly Report Blank

Selling—In putting the product on the market, Mr. Wightman has made it a point to call upon practically all the architects in the local territory—in many cases he has had to call repeatedly, but it is an interesting commentary upon the architect's attitude of mind that Mr. Wightman has obtained the ear of architects as to the merits of his tile product by introducing the subject in these words: "I am not offering you a concrete block." Mr. Wightman's company has not been selling a product for any architectural purposes—it is a straight bulk sales proposition, and once given a hearing, he has been able in a great many cases to convince architects and builders of the economy and stability of his product as compared with competing products on the market. Not satisfied, however, with a promise on the part of the architect that he would perhaps use the material on some subsequent job, the Delta company has "followed" the architect persistently with form letters, at the bottom of which are attractive half-tone illustrations of the tile in the units of various sizes and with practical information as to the use of the product. Further, once every week the company sends out a post card reminder to all architects and builders on its mailing list. This post card, from week to week, carries the same message for the most part, showing the same attractive illustration of the units stating their dimension as they are shown on the stationery, and the card is changed each week in the center panel, each time giving some new message or some variation in the statement of a fact previously announced. In addition, however, to this method of approach, the Delta company has some very strong arguments, but none is stronger than that of the economy of the material. One of the principal talking points in favor of this tile is that, at least in the Detroit territory, it is cheaper than clay brick, at $3.00 per M. This is a very strong point, because clay brick in Detroit territory usually cost $8.00 per M. But that is not the only economy over clay brick. In view of the fact that a unit 5" x 8" x 12" occupies the space in the wall of 6.4 clay brick, it is perfectly obvious that less mortar is required in laying up a wall of the concrete unit. Comparison of the figures for clay brick and for this tile is as follows: Structural tile in 5-in. x 8-in. x 12-in. units, cost at the yard $38.00 per M; freight, $1.20; teams, $4.80; total on the job $44.00. Labor per M, laying up, $12.50; mortar per M, $4.50; total $61.00 per M in the wall. Dividing this $61.00 by 6.4, we find that common brick would have to be laid up in the wall at $9.20 per M, in order to compete on equal basis with concrete tils. However, the actual cost of clay brick in the Detroit market, is as follows: Brick per M, $8.00; labor per M, laying up (1 mason, and 1 laborer), $7.00; mortar per M, $1.75; a total of $16.75 per M in the wall, which is in excess of the cost, to compete with the tile, of $7.54.

Then, for foundation work and heavy walks, Mr. Wightman figures that mass concrete costs $6.80 per cu. yd. while the concrete tile can be laid up at $5.25 per cu. yd.

Personnel—Officers of the Company are: Albert L. Stephens, pres.; S. H. Wightman, vice-pres. and gen. mgr.; S. McIver, secy.

When using wheelbarrows as a unit of measure, they should be brought to a level when filled; a small top on the wheelbarrow load looks like a small matter, but may in fact mean a material decrease in the proportional amount of cement. Wheelbarrows containing the required amount when level full can easily be obtained. Bottomless boxes made to set in the wheelbarrow can also be used to measure the materials correctly.

The method of coating concrete surfaces with ordinary linseed oil until it ceases to be absorbed is sometimes used. There are two difficulties encountered in using an oil of this nature on concrete: First, linseed oil is an unstable compound and does not have a very long life; again, the oil coming in contact with the cement produces a soap which is soluble in water and is soon washed off.

No steel reinforcement should be painted or oiled, as either treatment will lessen the adhesion of the concrete. No grease or foreign matter of any kind should ever come in contact with the steel.

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[6] Wabash Portland Cement Co., Detroit

Construction of Concrete Roads in Milwaukee County, Wisconsin, in 1914

By H. J. Kuelling[1]

Milwaukee Co., Wis., which includes the city of Milwaukee, is 24 mi. long by about 10 mi. in width. The topography is of a glaciated nature varying from flat sections that are difficult of drainage to fairly steep hills running as high as 15% grades. The soil varies from sand to very heavy clay. Thus we find in the county about all the possible conditions for the foundation of concrete roads.

When Milwaukee Co. began, several years ago, to improve its rural roads, considerable time was given to the study of the various types of road that would be suitable to its conditions. Not only was the heavy mixed traffic, common near a large city, taken into consideration, but the fact that the manner of transportation, both of freight and passengers, was and is rapidly changing from horse-drawn to motor-drawn vehicles. These conditions plainly showed that the construction of water-bound or gravel macadam, or any other type of pavement that was not rigid within itself, would be unsatisfactory. This brought the county to the consideration of concrete, brick and bituminous macadam, the latter two of which would be built on a concrete foundation. While it was recognized that there are both advantages and disadvantages in the concrete road, it was adopted as the standard for one reason above all others, namely, that it would eventually, no matter what its life, be available as a first-class foundation for any kind of surfacing.

In 1911, the Milwaukee Co. Board took action whereby it might improve the main roads in the county under what is known as the state aid highway law. The first steps taken were the election of a county highway commissioner and the selection of the system of prospective state highways. This system of roads consisted of the main arteries leading from the important market points of the county to the county line. The system contains about 170 mi. out of a grand total of 450 mi. within the county.

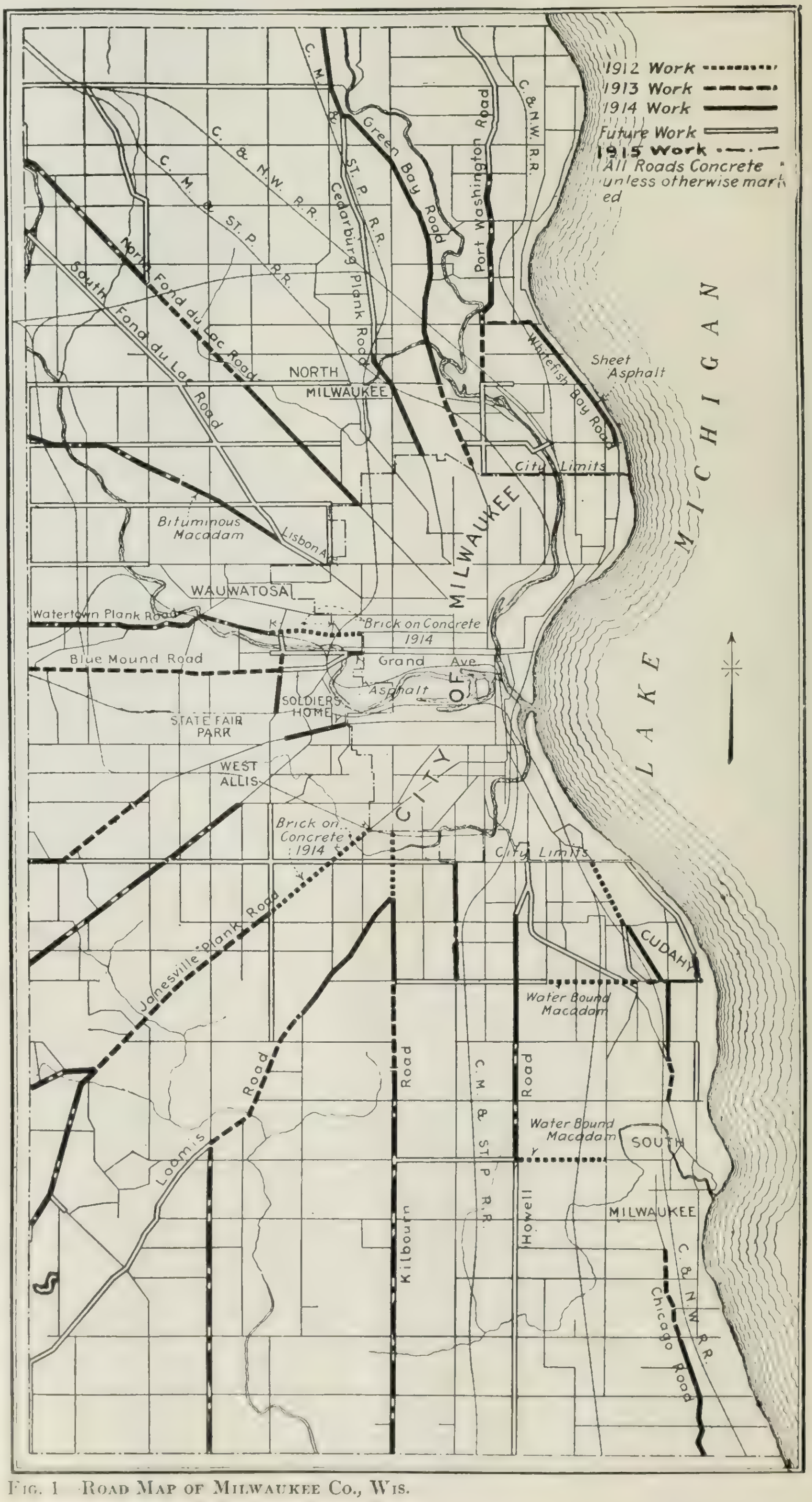

Fig. 1 Road Map of Milwaukee Co., Wis.

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[1] Highway Commissioner, Milwaukee County, Wis.

It was well into the year of 1912 before plans could be completed for the construction of any roads because the selection of the roads to be improved was not made until late and the highway department was unable to get the plans completed until along in the summer. Such delays are now done away with by having all the surveys done in the fall and plans drawn up in the winter, thus enabling the highway committee and the commissioner to let contracts and plan their work during the very early spring. In 1912 there were constructed about 6 mi. of concrete. In 1913 a much earlier start was made and as a result, 22 mi. of concrete were constructed, of 16-ft. and 18-ft. width, with a few sections that were wider.

In the year of 1914, there were constructed about 25 miles of concrete roads besides 1¼ mi. of brick, 2 mi. of tar macadam and 4 mi. of sheet asphalt. With the exception of some of the sheet asphalt this work was practically all completed by the first week in Oct.

Plans for 1915 call for the completion of about 40 mi. of pavement. At the end of the season 1915, it is expected that there will be 12 roads completed from the city of Milwaukee to the county line. By examining the map which is shown in Fig. 1, it will be noted that the county is building its system of roads in a continuous manner rather than a small piece here and there with the ultimate intention of connecting these pieces.

The amount of work done in this county last year is probably as large as, if not larger than, that done in any other similar community in the Middle West.

Some idea of the magnitude of this undertaking can be gained by the fact that about 4,000 car loads of material were used and more than 430,000 bags of cement.

ORGANIZATION

The organization for handling this work is illustrated in Fig. 2, and is made up as follows: The highway commissioner, who has immediate supervision of all of the work; the assistant highway commissioner, who assists in various capacities; the chief clerk, who attends to the correspondence, pay-rolls, writing of checks and distribution of amounts; the traffic man, who attends to all matters pertaining to shipments and accounting of freight and cement; the superintendent of construction, who is in direct charge of all the outside work; the surveying party of from three to five members, who make all surveys, do all the platting and compute all of the yardage.

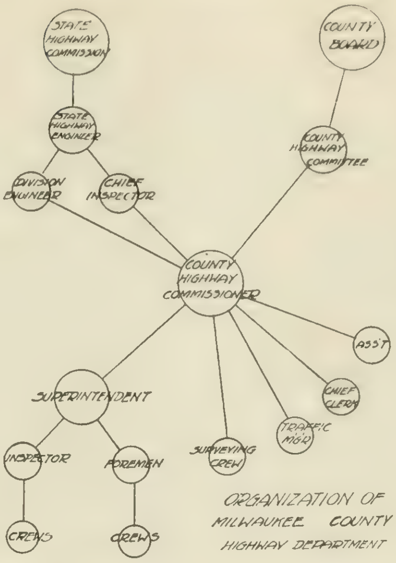


Fig. 2—Organization of Milwaukee Co. Highway Dept.

CONSTRUCTION

While in 1913 the concrete work was done one-half by contract and one-half by force account, the work in 1914 was done almost entirely by contract. This was due to the extremely low bids received owing to cheapness of labor and teams and a great scarcity of contract work in the vicinity.

Plans for the work and computation of quantities were made in the winter of 1913 and most of the bids were received in Mar. and Apr. of 1914. This permitted the earliest possible start and the completion of the concrete road work by about Oct. 1, 1914, thus giving the roads a chance to harden thoroughly before any frost came, a point which the writer believes to be of the utmost importance in concrete road work.

Even though done by contract, the work demanded much detailed attention, as all of the cement was furnished delivered on the job by the county and the sand and gravel were shipped to the county highway commissioner whose office force looked after the rates, weights and quality of the material. All of the freight was paid by the highway commissioner and the amounts later deducted from the contractors' estimates. The reason for such procedure is that it gives the highway commissioner a direct check on the amount of material going into each job and does away with any tendency on the part of the contractor to slight the quality of the concrete, especially when it comes to the use of the proper amount of cement.

By purchasing its cement, the county has been able to buy it at a lower market than the contractor would have been able to buy it at the time of the letting of the contracts. thus causing a saving of many thousands of dollars to the county.

One clause in the contract reads as follows:

> In case the county furnishes the cement delivered either f. o. b. cars or on the work, bags will be charged to the contractor at the rate of 10 cts. each, which will be credited to him upon the return of the same in acceptable condition to the company furnishing the cement. The contractor shall tie the sacks in bundles of 50 each in a manner approvel by the commissioner and shall procure from said company receipts for said bags, in addition to marking the number on both copies of the delivery tickets at the time the said sacks are turned over to the cement company's teamsters. Each bundle shall be tagged in such a manner as will show completely the name of the contractor to whom credit should be given, as well as the name of and the number of the road. Any bags which may become lost, torn, hard, or otherwise not acceptable to the receiving company, shall be paid for by the contractor. Any cement which may be delivered in good condition f. o. b. cars or on the work, and which may become lost or unfit for use through negligence of the contractor or his employees, shall be paid for by the contractor at the rate which is charged to the county by the company delivering the cement. The contractor shall provide facilities on the job for properly protecting and keepin in good condition at least 1,000 bags of cement.

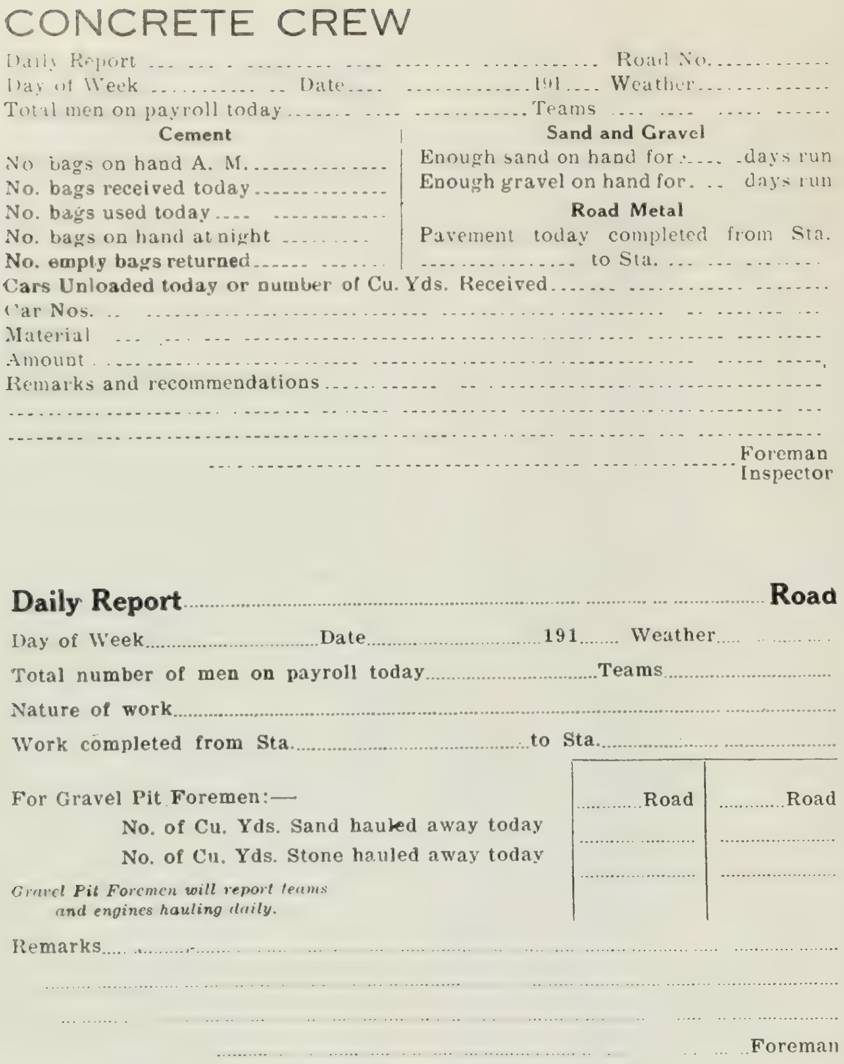
REPORTS

No matter whether done by contract or day labor, the county man on the job, either as inspector or foreman, is required to make a daily report as shown in Fig 3. These are self-addressed and come to the highway commissioner's office the following day. From these reports the office man checks the amount of cement used against the cement received as shown by the duplicate delivery tickets received from the delivering company. The amount of cement used per sq. yd. of pavement is checked each day to see that the proper mix is being obtained. The progress of the work on each job is platted as shown in Fig. 4. From this plat the commissioner can, at a glance, note the progress, the date of construction of any piece of work, the proper date for opening to traffic, the proper distance back for sprinkling, the cause of delays and many other important points in connection with the work.

PREPARATION OF ROADBED

In 1914 the field construction was carried on in a manner quite similar to that of 1913. After the roads had been surveyed and the plans drawn up the profiles were changed until the cuts and fills were made to balance. This is done by having the area of the cross-section at each station computed with a planimeter.

The cost of the grading in 1914 is somewhat lower than that of 1913



CONCRETE CREW

Daily Report .... Road No. ....
Day of Week .... Date .... 191.... Weather ....
Total men on payroll today .... Teams ....

Cement	Sand and Gravel
No. bags on hand A. M.	Enough sand on hand for .... days run
No. bags received today	Enough gravel on hand for .... days run
No. bags used today	**Road Metal**
No. bags on hand at night	Pavement today completed from Sta.
No. empty bags returned	.... to Sta. ....

Cars Unloaded today or number of Cu. Yds. Received ....
Car Nos. ....
Material ....
Amount ....
Remarks and recommendations ....

.... Foreman
.... Inspector

Daily Report .... **Road**

Day of Week .... Date .... 191...... Weather ....
Total number of men on payroll today .... Teams ....
Nature of work ....
Work completed from Sta. .... to Sta. ....

For Gravel Pit Foremen:—

	............Road	............Road
No. of Cu. Yds. Sand hauled away today	....	....
No. of Cu. Yds. Stone hauled away today	....	....

Gravel Pit Foremen will report teams and engines hauling daily.

Remarks ....

.... Foreman

Fig. 3—Post Card Report Forms Used in Milwaukee Co.

as will be noted in the accompanying table. Teams were paid at the rate of $5.00 per da. of 10 hrs Common labor was paid about $2.00 per da. of the same length. Practically all of the grading was done either with wheelers or slip scrapers, although steam shovels and dump wagons were used in a few cases. It is believed advisable to grade for a considerable distance ahead in order to give the ground plenty of time to compact thoroughly before the concrete is placed. Where underground springs were encountered, tile drains were placed running from the center of the road to side ditches. The roads were graded to cross-sections as shown in Fig. 6. It will be noted that the sub-grade is flat and the crown of the road is cared for by making the concrete thicker in the center of the pavement.

TYPE AND MIXTURE

All of the work done was of one-course type which was 6″ thick at the edges and 8″ thick at the middle or a uniform thickness of 7″.

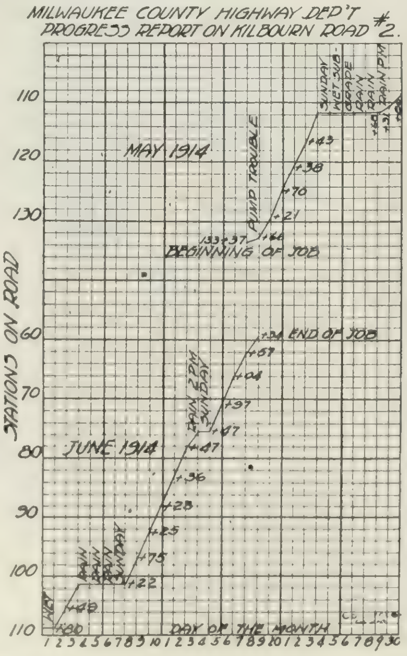


Fig. 4—Progress Report of Road Work
Kilbourne Road is a standard concrete road, 18′ wide, 6″ thick at edges and 8″ in center; station distance 100′

where placed on either side of a car line.

On all of the roads except 2 mi., earth shoulders were constructed because it was found that after one yr.'s wear, the earth shoulders gave as good satisfaction as the shoulders constructed of gravel, if not better, and, of course, were somewhat cheaper

The general mix used in 1914 was 1:2:3½, although this was varied a little where the voids in the aggregate were found to be very low. All the cement used was tested, by contract, at the mills, with an occasional test made in the laboratory of the highway commissioner. Practically all of the sand and stone was washed and in every case the sand and stone were brought on to the job separately. A large number of tests were run on both sand and stone to determine the percentage of voids, percentage of clay and silt, percentage of siliceous material in the sand, and the nature of the stone composing the larger aggregate. These tests were made both before the work was commenced and from time to time upon samples obtained from the job. Some idea of the thoroughness of these tests can be gained from the fact that about 25 cars of cement and about 50 cars of sand and gravel were rejected from time to time in the summer.

The sand was graded from ¼″ down, with not more than 3% passing a 100-mesh screen. With such sand a 1:2 mortar gives a very strong mixture and in the writer's opinion is preferable to a richer mix where the sand is limited to ⅛″. The larger aggregate was in most cases graded from 1½″ to ¼″. In some well graded aggregate the voids were found to run as low as 35%.

TRANSPORTATION OF MATERIALS

Most of the material was hauled by team, although a considerable amount was moved by steam tractors with heavy wagons containing about 3½ yds. each, a train consisting of anywhere from three wagons to six wagons. A comparative cost of the two methods is not available at this time as the writer has not access to the figures of the various contractors. However, under the same conditions in 1913, the cheapest hauling was done with a combination of teams and steam tractors. One advantage that might be noted for tractor hauling is that the wagons left the material in deep piles and therefore caused less loss due to the material getting into the sub-grade. Where tractors were used, the trains were pushed into place before being dumped rather than backing the empties out. It is

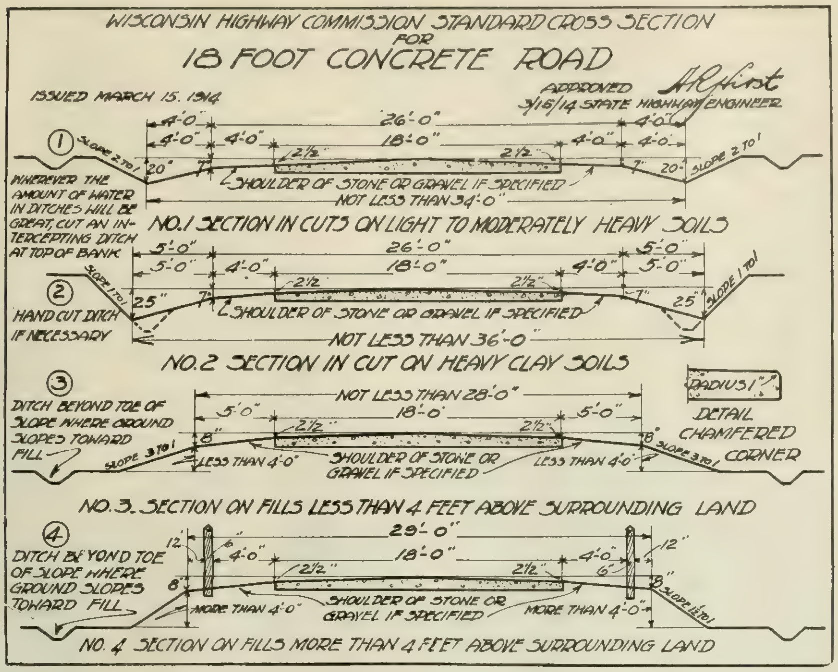

WISCONSIN HIGHWAY COMMISSION STANDARD CROSS SECTION
FOR
18 FOOT CONCRETE ROAD
ISSUED MARCH 15. 1914
APPROVED
3/16/14 STATE HIGHWAY ENGINEER
A R Hirst
①
WHEREVER THE AMOUNT OF WATER IN DITCHES WILL BE GREAT, CUT AN INTERCEPTING DITCH AT TOP OF BANK
4'-0"
26'-0"
18'-0"
2½"
20"
7"
SLOPE 2 TO 1
SHOULDER OF STONE OR GRAVEL IF SPECIFIED
NOT LESS THAN 34'-0"
NO. 1 SECTION IN CUTS ON LIGHT TO MODERATELY HEAVY SOILS
②
HAND CUT DITCH IF NECESSARY
5'-0"
25"
SLOPE 1 TO 1
NOT LESS THAN 36'-0"
NO. 2 SECTION IN CUT ON HEAVY CLAY SOILS
③
DITCH BEYOND TOE OF SLOPE WHERE GROUND SLOPES TOWARD FILL
NOT LESS THAN 28'-0"
8"
SLOPE 3 TO 1
LESS THAN 4'-0"
RADIUS 1"
DETAIL CHAMFERED CORNER
NO. 3. SECTION ON FILLS LESS THAN 4 FEET ABOVE SURROUNDING LAND
④
DITCH BEYOND TOE OF SLOPE WHERE GROUND SLOPES TOWARD FILL
29'-0"
12"
6"
MORE THAN 4'-0"
SLOPE 1½ TO 1
NO. 4 SECTION ON FILLS MORE THAN 4 FEET ABOVE SURROUNDING LAND

Fig. 5—Standard Cross-Sections for 18-Ft. Concrete Roads, 1913

believed by the writer that for hauling purposes tractors which have beveled wheels are preferable because the crown of the road over which the hauling is done should not be disturbed. Such beveling would also be advantageous on the engine wheels, as cases have come to the writer's attention where every spoke in the drive wheel was broken, due to the entire load being carried on the inner edge of the rim.

Material was placed on the road in two different ways. In one case, the rows of sand and stone were placed together and teams delivering cement were compelled to drive on the berm. In the other case the sand and stone were separated and the cement teams permitted to drive up the middle of the road. It is believed slightly advantageous to get a large amount of material ahead in order to avoid possible delays in shipping and any delays in hauling. On the other hand, it is inadvisable to have too much material on the job as a certain percentage is always wasted in wet weather due to becoming mixed with the sub-grade.

WATER

The supply of water to the various jobs was handled in a manner similar to that of 1913 In all cases a 2-in. pipe line was laid from the nearest source of supply and where necessary a small gasoline engine or steam boiler supplied for forcing the water to the mixer. It has been the writer's experience that unless a valve about as often as the unions. 2-in. hose are placed every 400′ and the distance exceeds 3 mi. and the elevation exceeds 100′ a 2-h.p. gasoline engine is sufficient to furnish the necessary power as there is very little friction in a 2-in. pipe where only 4,000 gals. are supplied in a day. It is advisable to have the engine connected with the pump by a belt in order to avoid the danger of breaking the cross-head in the pump, where for any reason the crew stops the flow of water through the pipe. The most satisfactory safety device for caring for excess pressure was the erection of a stand-pipe beyond the mixer. This standpipe was nothing more than one length of pipe turned into a T. Such a contrivance keeps the pressure fairly uniform and in cases of delays on the job does not necessitating the pump starting a long column of water. While erecting the pipe line, unions are placed about every 1,000′ thus enabling repairs to be made quickly and easily. T's with connections for On each job there are about 225′ of 1½-in. hose for supplying the mixer and about the same length of small hose for sprinkling purposes.

CREW.

While the different contractors had crews made up in various ways, the writer believes the following to be an efficient crew for county road work:

One foreman, one straw boss, one mixer engineer, one fireman, one finisher, three men receiving and striking off concrete, two men handling cement, three men handling sand, eight men handling stone, two men caring for forms and erecting all

Contract Prices for Concrete Roads in Milwaukee Co. in 1914

	Green Bay Rd. No. 2	Green Bay Rd. No. 3	Cedarburg Rd.	Hawley Rd.	Loomis Rd. No. 1	Kilbourn Rd. No. 2	Chicago Rd. No. 5	Howell Ave.	Pt. Washington Rd.	Fond du Lac Rd.	Eighth Ave.	Lynn Ave.	Ave. Packard
Earthwork No. cu. yds.......	4,937	10,386	2,842	2,438	6,590	3,736	4,400	4,617	2,700	3,100	2,400	350	
Earthwork Cost cu. yd........	0.52	0.44	0.60	0.58	0.60	0.52	0.68	0.62½	0.55	0.60	0.44	0.45	0.45
Concrete No. sq. yds.......	25,400	38,400	15,800	9,200	27,000	14,800	22,100	21,000	10,000	29,600	10,286	9,400	17,225
Concrete Type A. Cost.....	0.73	0.85	0.83	0.79	0.96	0.74	0.86½	0.93	0.74	0.74	0.70	0.68	0.68
Concrete Type B. Cost.....	0.71	0.83	0.81½	0.77½	0.94	0.72	0.84½	0.91	0.72	0.72	0.68	0.68	0.68
Culverts No. cu. yds.......	10	115	30	26	30		71	30	34	57		42	
Culverts Cost cu. yd.	5.95	5.95	11.00	8.00	5.95	5.95	7.00	9.50	10.00	10.00		10.00	
Extras cost plus %.	10%	10%	20%	15%	10%	10%	10%	20%	20%	20%	10%	10%	10%
Average haul in mi.	2½	2	1	1½	3	2¼	2	3	½	2	¾	¾	¾
Cost cement, per bbl.	1.34	1.35	1.24	1.35	1.39	1.39	1.37	1.39	1.28	1.36	1.34	1.29	1.29
Cost cement Per sq. yd........	0.45	0.46	0.42	0.46	0.47	0.47	0.46½	0.47	0.41½	0.46	0.45	0.42	0.42
Gravel shoulder, Lin. ft.			7,900	4,600									
Gravel shoulders Cost per lin. ft...			0.15	0.15									

Notes—Type "A" joints include two pieces of protecting steel and ¼" of felt while type "B" joints include felt only.

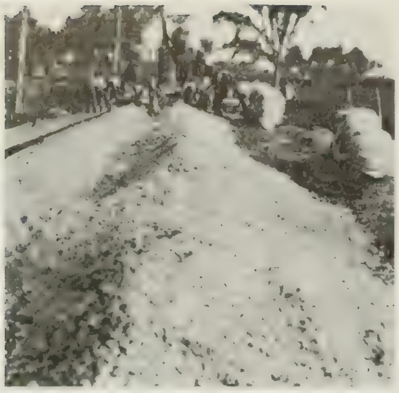


Fig. 6—Materials on Sub-Grade, North Fond du Lac Road, Milwaukee Co., 1913

joints, one man for evening up and hand-tamping sub-grade, one man for covering and sprinkling, one for running pump, one water-boy, who also cares for the cement sacks, and one watchman.

This gives a crew of 28 men, who under favorable conditions, should mix and place an average of about 600 sq. yds. of pavement per day.

The writer believes that the batch should consist of 2 bags of cement, 4 cu. ft. of sand in one wheelbarrow and 7 cub. ft. of coarse aggregate in two wheelbarrows. Such a combination makes fewer whelbarrows to dump, thus loading the hopper more quickly and lessening the chances for errors in geting the proper mixture in any batch. Such loads may seem abnormal but the writer's experience has shown that men are willing to do it as it necessitates fewer trips every day for each man although each trip is harder.

PLACING THE CONCRETE

Forms were placed as far as possible in advance, especially on one side, thus enabling the inspector to note any sudden change in the grade or alignment. Forms used were generally 2x6 planks with or without angle iron facing on one edge. Planks were staked in line with iron pins. The concrete was put in place in some cases by a spout and in some cases by booms, but in no case by carts.

Unless two-course pavement is to be built, the writer believes that the spout is preferable for narrow road work. The concrete was placed with a fairly stiff consistency so that there would be no separatation of the mortar and stone. It was found that there was no tendency on the part of the contractor to mix too dry, while there was a very marked tendency to mix too wet. As soon as the concrete was placed it was struck off in all cases with an iron-shod board cut to the crown of the road. The finishing consisted merely in smoothing out the marks of the strike-off board and removing any foreign matter which might have gotten into the aggregate and which in all cases will float to the surface, the idea of little finishing being to leave the aggregate as near the surface as possible and not to work any appreciable amount of mortar to the top.

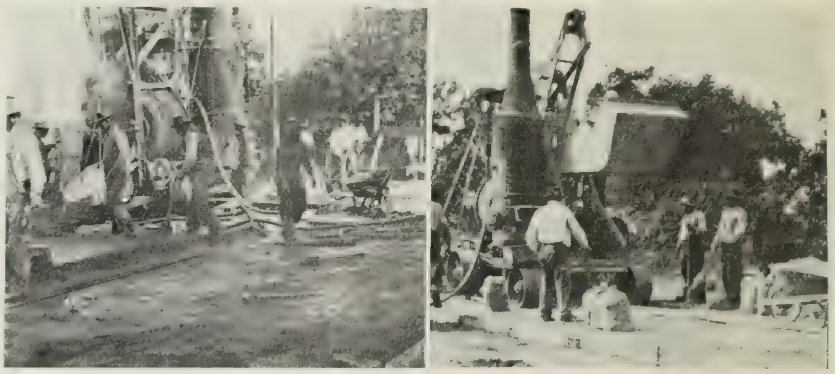


Fig. 7—Two Views of Mixer and Mixer Gang on Concrete Road Construction, Milwaukee County

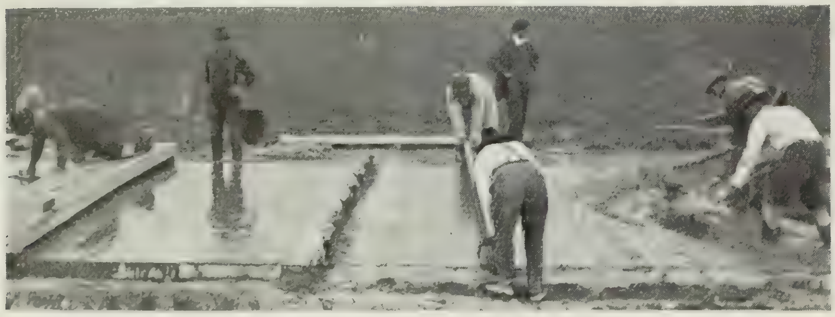


Fig. 8—Depositing Concrete and Finishing, Green Bay Road, Milwaukee Co., 1914

CURING

The first step in curing a concrete road was found to be the sprinkling of the sub-grade when it was found to be very dry. This was done generally by the fireman who connected a small hose to the injector. When the temperature was over 90° or when a hot wind was blowing, the concrete was protected with canvas until hard enough to sprinkle. After it had sufficiently hardened, it was covered with earth from the road side and kept wet (not merely sprinkled) for about 12 das. The roads in practically all cases are closed from traffic for three wks. and if anyone is foolish enough to attempt the construction of concrete roads after Oct. 1 in our latitude, traffic should be barred for a considerably longer

(Continued on Page 110)

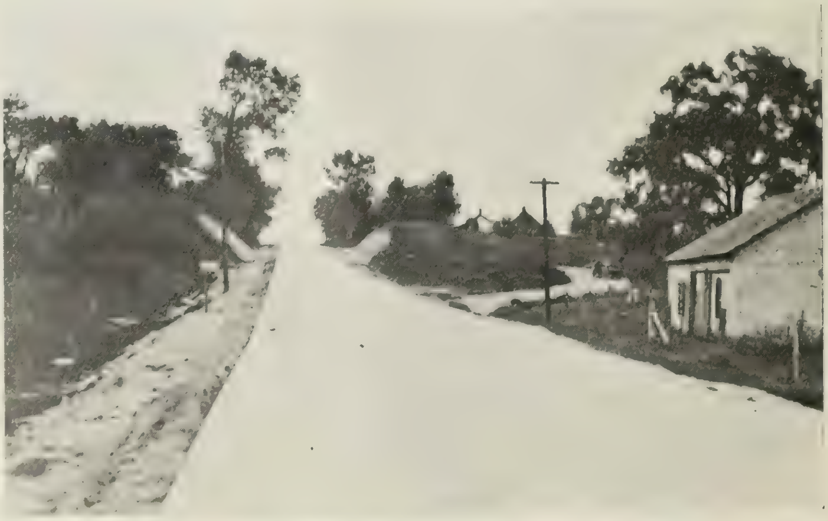


Fig. 9 Re-location of Green Bay Road Showing 12-Ft. Cut, Milwaukee Co., 1914

Methods and Costs of Constructing the Bay St. Underpass at Macon, Ga.

By Carl H. Fuller[1]

Bay St. is one of several streets crossing the western throat of the Central of Georgia Ry. Co.'s busy switching yards in Macon and connecting the western portion of the town with that portion of the "city reserve" beyond these yards, given over to various industrial enterprises. In addition to the above freight yard that strip of territory occupying the space between Fifth St. and Sixth St. is occupied on the Sixth St. side by two main line tracks of the Southern Ry. while one main line track of the Georgia Southern & Florida Ry. occupies an encroachment on Fifth St., making a total of 16 tracks and two streets to be crossed in a distance of some 465′ on Bay St., as shown in Fig. 1.

Between these two parts of the town there is a large amount of heavy teaming, which is steadily increasing with the development of the City Reserve. Owing to the ever present danger and constant interruptions to travel caused by numerous main line trains and switching operations, the installation of a protected crossing had been agitated for some time and finally crystallized into an agreement between the City Council and the Central of Georgia Ry. that the latter should construct at Bay St. an underpass, beginning near Broadway (Fourth St.) and passing below Fifth St., under the 16 tracks mentioned, and rising to grade near Seventh St. in the "Reserve."

Accordingly plans were prepared under the direction of C. K. Lawrence, chf. Engr. for the Central of Georgia Ry., embodying the following features: Beginning at the Broadway end the roadway is depressed on a 10% grade for 122′ 6″ to Fifth St., continuing through a tunnel under the tracks on a 0.2% grade to Sixth St., where ample drainage facilities are provided to keep the subway free from water under all conditions of weather and rising from this point to the surface near Seventh St. on a 10% grade in a distance of 160′, making a total of 742′ 2″ (see Fig. 1).

Referring to Fig. 2 it will be noted that a 20-ft. roadway is provided, having a clear head room of 13′ 6″ with the addition of one 5-ft. concrete sidewalk elevated 3′ above the roadway under the tracks. The paving of this roadway was not a part of the general contract but was paved with 8″ of concrete by the City Paving Dept. on the completion of the subway.

Thirty-seven hundred sixty-one cu. yds. of plain concrete, having proportions of 1:3:6 were used in constructing the side walls and abutments, which are, under the tracks, 3′ thick at the top, 7′ 6″ thick at the base and rest on spread footings 10′ wide. The wing walls of the approaches were designed to serve merely as retaining walls and the abutments under the two roadways are of similar but lighter construction.

Probably the most interesting feature from an engineering standpoint is the track floor, which is built up of 26-in. Bethlehem I-beams weighing 150 lbs. per ft. and spaced 3′ apart, supporting an 8-in. concrete floor slab reinforced with corrugated bars[2], the concrete being extended down to the bottom flanges of the beams forming a haunch which reduces the clear span of the floor slab to 16″, as shown in Fig. 3.

The top of this floor was waterproofed with Barrett Specification five-ply felt and pitch[3] and paved with hard burned brick laid flat and grouted with pitch. On this for a floor the ties for the track were bedded in 15″ of broken stone ballast, a form of construction readily admitting of changes in alignment or slight changes of grade.

The Fifth St. roadways were constructed in much the same manner, 18-in. I-beams being used, while the concrete floor slab was reduced to 6″ but reinforced with Steelcrete[4] while the waterproofing was applied with a coating of gravel instead of brick.

Standard three-rail pipe railings composed of 1½-in. and 2-in. wrought iron pipe and fittings were used to protect the portals and the sidewalk in the subway, while a 6½-ft. board fence was erected between the tracks and the Fifth St. roadway.

Detailed bids on the general contract were received in June, 1913, the final award being made to the Southern Eng. & Const. Co., Macon, which submitted the lowest of 21 bids, ranging from $58,511.75 to $86,702.20. Actual construction began in August under the personal direction of Chas. M. Preston, the president of this company, and progressed without serious interruption until completed 8 mos. later, the greatest delay being occasioned by the inability of the railways to surrender the use of more than two of their tracks at a time, two wks. being required to construct the floor sections and allow the concrete to set sufficiently to take the load.

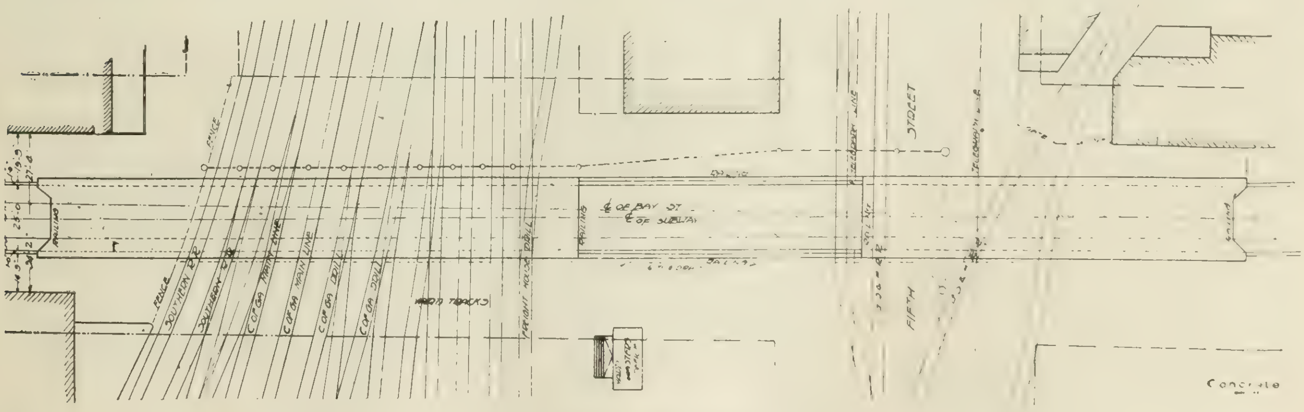


Fig. 1—Plan of Bay St. Underpass, Showing Track Layout.—Macon, Ga.

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[1] Cons. Engr., Evansville, Ind.

[2] Corrugated Bar Co., Buffalo.

[3] Barrett Mfg. Co., N. Y. C.

[4] The Consolidated Expanded Metal Companies, Braddock, Pa.

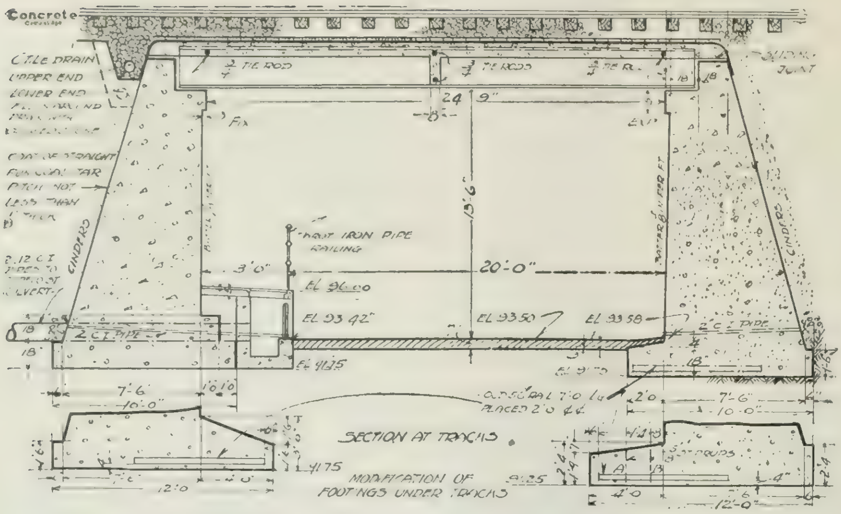

Fig. 2—Cross-Section of Bay St. Underpass at Tracks

The preparatory work of taking care of its tracks and those of the adjacent railways during construction was done by the Central of Georgia Ry.'s own forces and consisted principally in providing for an underground false work to carry these tracks and roadways during the excavation and construction. Two of the tracks were shifted in their alignment and some slight changes in grade made to anticipate developments in the yard below.

The 16 tracks and two roadways, one 10′ and the other 16′ wide, were each carried on five rows of three-pile bents, extra piles being used where the tracks were doubled through the switches, requiring a total of 226 piles which were driven with a standard railway pile driver to a safe depth before excavation began. These were capped with 12-in. x 12-in. timbers which then carried triple 7½-in. x 15-in. track stringers under each rail, and extending 25′ beyond the outer bents onto solid foundation either way, as shown in Fig. 4. Between rail and stringers 8-in. x 8-in. sawed bridge ties were used and the whole area of streets and roadways floored with 2-in. x 10-in. planking. Portions of this temporary floor, and a portion of the abutment walls are clearly shown in the views. Two-in. x 10-in. bracing was applied in the plane of the bents as the dirt was removed and the whole structure was as thoroughly bolted and drift-bolted as though intended for a permanent structure.

Bids for the work were made out in detail for the various parts, as excavation, concrete, waterproofing, etc., and some of these items will be given detailed consideration in the matter of construction costs.

Sixteen thousand fifty-three cu. yds. of neat excavation were called for in the proposal sheet and figured at 55 cts. per cu. yd. This part of the work was sublet to J. White, a local grading contractor, for 47 cts. Excavated material was disposed of on adjacent property, most of it being hauled less than 500′ from the portals of the subway. Excavation of the approaches was easily and rapidly handled with wheeled scrapers for 14 cts. per cu. yd. but under the trestle supported tracks the scrapers had to be abandoned in favor of one-horse dump carts loaded with pick and shovel, this work costing 27 cts. per cu. yd., down to 4′ above sub-grade where owing to the necessity of taking care of water the cost of handling jumped to 60 cts. and 75 cts. per cu. yd. Team and negro driver were paid or allowed stable charges of 40 cts. per hr.

Included in the unit cost of excavation was the removal of the piling after the superstructure had been finished and this cost $4.50, practically $2.00 per pile. Excavation also included backfilling around the abutments using 1′ of cinders next to the wall to admit of sub-soil drainage.

Naturally in a job of this kind the important item is the concrete, which was of three classes, the following being the quantities and price bid:

3,761 cu. yds. plain concrete @ .	$ 6.00 per yd.
324 cu. yds. of reinforced class A concrete @	15.00 per yd.
127 cu. yds. of reinforced class B concrete @	17.50 per yd.

Plain concrete of the proportions of 1:3:6 using 1¼-in. crushed Birmingham slag was used for all of the monolithic work such as wing walls, footings and abutments under the tracks.

Class "A" concrete, having the proportions of 1:2:4, using ¾-in. crushed granite from the Parker quarry, was used for the reinforced floor work under the tracks, the price bid including the Johnson reinforcing bars[2] costing $33 per ton f. o. b. Macon.

Class "B" concrete, used in the Fifth St. and the Sixth St. roadways, was of the same proportions but was reinforced with Steelcrete mesh[4], which was included in the price bid.

The following material was used in putting up these three classes of concrete:

5,200 bbls. of Portland cement in bags, per bbl. net	$ 1.62
2,300 cu. yds. pit sand per wagon load of 24 cu. ft.	0.75
4,000 tons crushed slag @ 30 cts., freight @ 95 cts.	1.25
450 tons ¾-in. crushed granite	1.52
54 M. ft. of lumber for forms	16.00
37.8 tons of Johnson bars per ton	33.00
512 sq. yds. of Steelcrete, per yd	0.64

Form work naturally forms an important part of the erection costs of concrete, 2 x 10's being used for lagging throughout, a good portion of this material being used the third and fourth time, giving a material cost of 20 cts. per cu. yd. on the plain concrete and 25 cts. per cu. yd. on the reinforced work. Carpenters were paid at the rate of $3.33 per 10-hr. day and their labor reduces to 75 cts. per cu. yd. on the plain concrete and $1.75 on the reinforced work.

The method of mixing, handling and placing of concrete was simple yet effectively cheap. The Insley

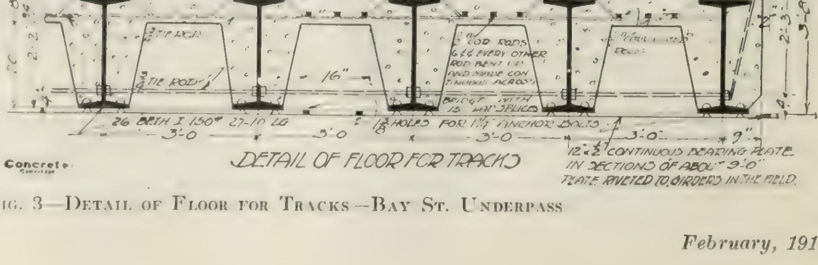
WROT IRON PIPE RAILING
8'-0"
WATERPROOFING: BARRETS FELT AND PITCH 5 PLY
LAYER OF BRICK LAID FLAT, JOINTS FILLED WITH HOT SPECIFICATION PITCH
22 GALV INGOT IRON FLASHING
16"
26 BETH I 150# 27-10 LG
3'-0"
DETAIL OF FLOOR FOR TRACKS
12"x2" CONTINUOUS BEARING PLATE IN SECTIONS OF ABOUT 9'-0" PLATE RIVETED TO GIRDERS IN THE FIELD
Concrete

Fig. 3—Detail of Floor for Tracks—Bay St. Underpass

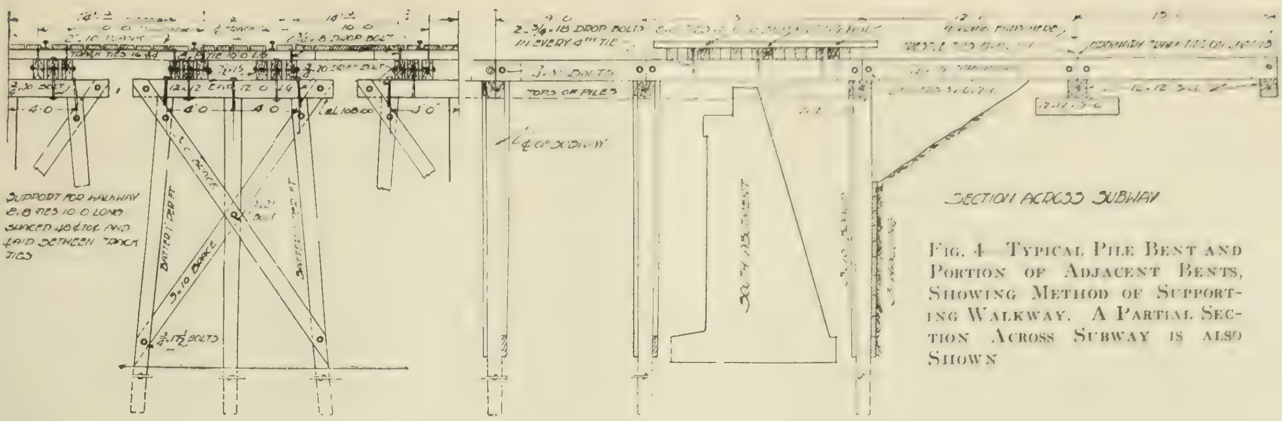

Fig. 4 Typical Pile Bent and Portion of Adjacent Bents, Showing Method of Supporting Walkway. A Partial Section Across Subway is also Shown

chuting system[5] suspended from wire cables attached to the top of the hoist was used, permitting a delivery of the wet concrete to any part of the work without any interference on account of the railway traffic (see Fig. 5). This equipment cost $1,300. The frame hoisting tower cost 50 cts. per ft. of height for material and $1.00 per ft. for labor to erect and about $25 to take down. Concrete was mixed in a ¾-yd. Standard batch mixer[6] placed adjacent to the base of the tower and operated by an electric motor, while another motor operated the hoist. The entire plant cost erected approximately $2,500 and allowing 15% for depreciation and labor in connection with its erection gives an equipment charge against the concrete of 9 cts. per cu. yd.

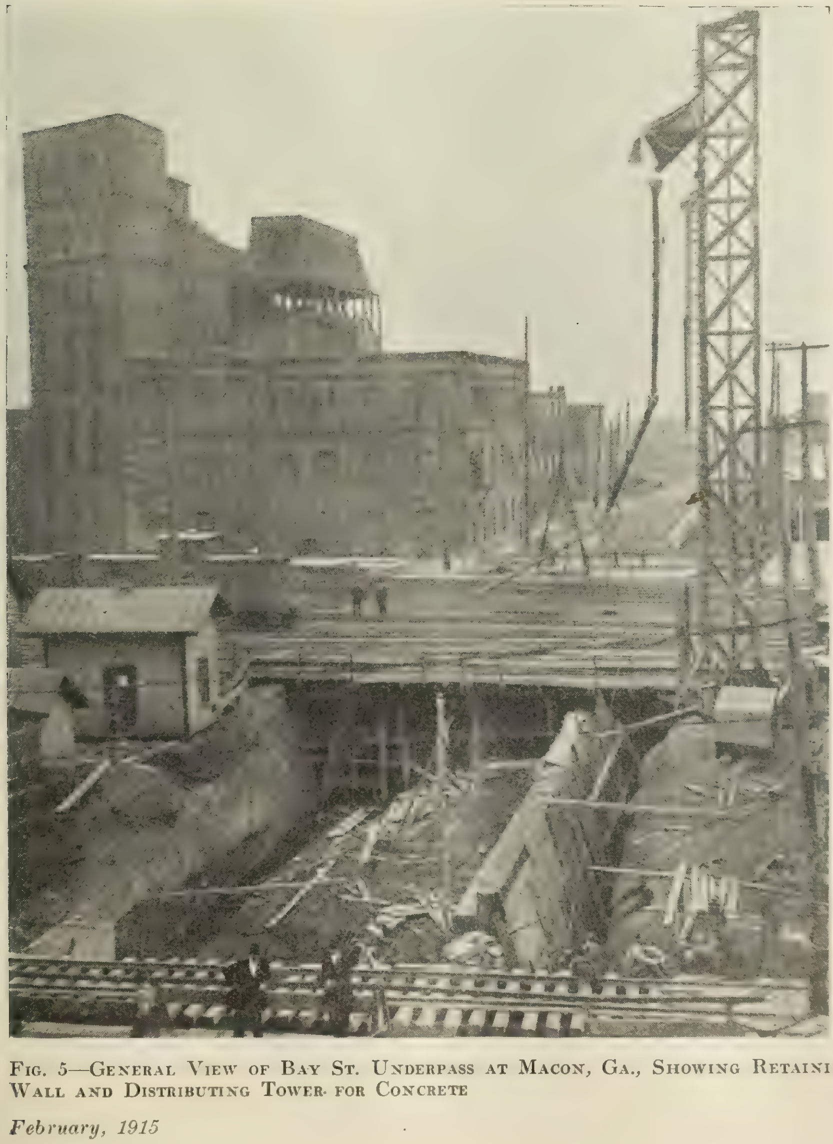

Fig. 5—General View of Bay St. Underpass at Macon, Ga., Showing Retaining Wall and Distributing Tower for Concrete

The labor cost of mixing and delivering the concrete to the forms averaged 62 cts. per cu. yd., although some sections of the work were placed for as low as 18 cts. Negro labor was used, being paid $1.25 per day of 10 hrs.

The above figures reduce to approximately the following unit costs per cu. yd, of concrete in place.

Plain concrete, 1:3:6

1.06 tons of crushed slag @ ..	$1 .32
0.57 cu. yds. of pit sand @ ..	0.48
1.1 bbls. of Portland cement @	1.78
Lumber for forms @........	0.20
Labor erecting forms including removal	0.75
Concreting labor @.........	0.62
Proportional equipment cost.	0.09
Total (exclusive of overhead)	$ 5.24 per cu. yd.

Class "A" concrete, 1:2:4 mixture

1 ton crushed ¾-in. granite..	$ 1.52
0.47 cu. yds. of pit sand delivered	0.39
1.6 bbls. of Portland cement.	2.59
Lumber for forms...........	0.25
Labor erecting and removing forms	1.75
190 lbs. Johnson bar reinforcing	3.14
Reinforcing labor	0.60
Concreting labor	0.62
Additional labor on reinforced concrete	0.38
Proportion of equipment cost	0.09
Total (exclusive of overhead)	$11.33 per cu. yd.

Class "B" concrete, 1:2:4 mixture

1 ton crushed ¾-in. granite.	$ 1.52
0.47 cu. yds. pit sand........	0.39
1.6 bbls. Portland cement....	2.59
Lumber for forms..........	0.25
Labor erecting and removing forms	1.75
403 sq. yds. of Steelcrete.....	2.54
Reinforcing labor...........	0.80
Concreting labor	0.62
Extra labor on reinforced concrete	0.38
Proportion of equipment cost	0.09
Total (exclusive of overhead)	$10.93 per cu. yd.

One hundred ninety-three and one-half tons of structural steel were used in the deck under the tracks and roadways, for which $60 per ton was bid, and sublet to the J. S. Scofield & Son's Co., Macon, at $53.50 per ton in place. This material consisted principally of 26-in. Bethlehem I-beams, weighing 150 lbs. per ft., under the tracks and 18-in. Bethlehem I-beams under the roadways, very little in the way of fitting and punching being required.

Class "A" waterproofing consisted

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[5] Insley Mfg. Co., Indianapolis

[6] The Standard Scale & Supply Co., Chicago

in applying 19,000 sq. ft. 1/8-in. thick of Barrett's common pitch to the backs of the retaining walls and abutments, for which the contractor received 1/2 ct. per sq. ft. but owing to the difficulty of applying to the damp concrete and cold weather this work cost 1 1/8 cts. per sq. ft.

Class "B" waterproofing consisted in applying 5-ply, of Barrett's Specification felt and pitch to 15,730 sq. ft. of the deck under the railway tracks, on which were laid hard burned brick flat side down and grouted with pitch. Fifteen cts. per sq. ft. was bid on this work, the waterproofing being let for $5.23 per square, not including the brick.

Class "C" waterproofing consisted of an application of 5-ply Barrett's Specification felt and pitch to the 6,000 sq. ft. of deck under the Fifth St. and the Sixth St. roadways for which 10 cts. was bid and which cost $5.33 per square, with 40 cts. added for gravel.

Seven hundred fifty lin. ft. of curbing varying from 8" x 18" to 8" x 36" was constructed for from 35 cts. to 40 cts. per ft. Three hundred seventy-five sq. yds. of 5-ft. sidewalk were constructed at a cost of 9 cts. per ft.

One hundred ft. of 7 1/2-ft. board fence painted two coats of red lead paint were constructed between Sixth St. and the railroad tracks at a cost of 50 cts. per sq. ft., including paint.

Seven hundred fifty lin. ft. of three-rail wrought iron pipe railing using 1 1/2-in. and 2-in. pipe were erected along the edge of the sidewalk in the tunnel and on the parapets at a cost of 73 cts. per ft., including paint.

In addition to the above there was considerable work included in the general contract in the way of changing old sewers, building new sewers and manholes and changing location of water mains, none of which presents any features in the way of costs or construction of sufficient interest to warrant incorporating in this article.

The entire cost of the subway was borne by the three railroads interested, with the exception of one-third of the cost of the concrete paving, which was borne by the City of Macon.

In using crusher-run materials as concrete aggregates, study crusher conditions so as to obtain a reasonably uniform product. Crusher-run sometimes means to the quarry man everything in his quarry that can be gotten onto a shovel. If the rock dust is not uniformly distributed it may be best to screen it out and use it as sand.

Notes on the Tests of Some Large Reinforced Concrete Culvert Pipe[1]

By W. J. Schlick[2]

In the summer of 1914 the Good Roads Section of the Engrg. Exp. Sta., in co-operation with the C. F. Massey Co., Chicago, made strength tests of reinforced concrete culvert pipes in sizes of from 18" to 48" in diameter. The purpose of these tests was to secure data on the supporting strength which would be comparable with similar data for other types of pipes and with data from future tests. The only previously published data on the strength of such pipe are those in Bulletin 22 of the Ill. Engrg. Exp. Sta. and are the results of tests conducted by Prof. A. N. Talbot. In Prof. Talbot's investigation the pipes were given the benefit of lateral support by being tested in a rigidly constructed box with the space (about 12") between the pipe and the side of the box rammed full of sand. In order to obtain data which would be comparable with those from tests of other kinds of pipe, the Iowa method of distributed sand bearing was used in these tests.

DESIGN OF TEST PIPES

All of the 13 pipes tested were made by the Massey Co. at its Chicago and its Minneapolis plant and furnished free of charge to the Experiment Station. The pipes were elliptical in shape, with one ring of circular reinforcing, thus bringing the reinforcing nearer the tension faces when the pipe is loaded with the long diameter vertical. The pipes were all of the type commonly known as "bell and spigot," and were in 8-ft. lengths, as shown in Figs. 1 and 2. The design was the same for all sizes, the only difference being in the dimensions of the pipes and in the amount and kind of reinforcing.

The reinforcing in 36-in. and 48-in. pipe was of 3/8-in. bars, spaced 3" and 3 3/4", respectively, with 3/8-in. longitudinal bars to which the circular rings were securely wired. By measurement after the pipes were tested the distances between the circular rings in some pipes were found to vary as much as 4". The pipes were designed to have the reinforcing at 1" from the tension face at top, bottom and sides. By measurements after the test, the greatest variation was found in pipe No. 703, in which this distance varied from 5/8" to 1 1/4".

In the other three sizes triangular mesh concrete reinforcement[3] was used, No. 4 mesh being used for the 18-in. pipe and No. 23 mesh for the 24-in. and 30-in. sizes. Measurements taken after the test did not check very closely with the standards for this mesh either in size of longitudinal wires or in the spacing between these wires. The percentages of reinforcing were calculated as the area of reinforcing in a unit section divided by the area of that section of the pipe wall between the center line of the reinforcing and the compression face of the tile wall.

TESTING MACHINE

In order to make strength tests of these large pipes a special machine had to be constructed. The general

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[1] From *The Iowa Engineer* for Dec., 1914

[2] Drainage Engr., Engrg. Experiment Station, Iowa State Coll., Ames, Ia.

[3] Am. Steel & Wire Co., Chicago

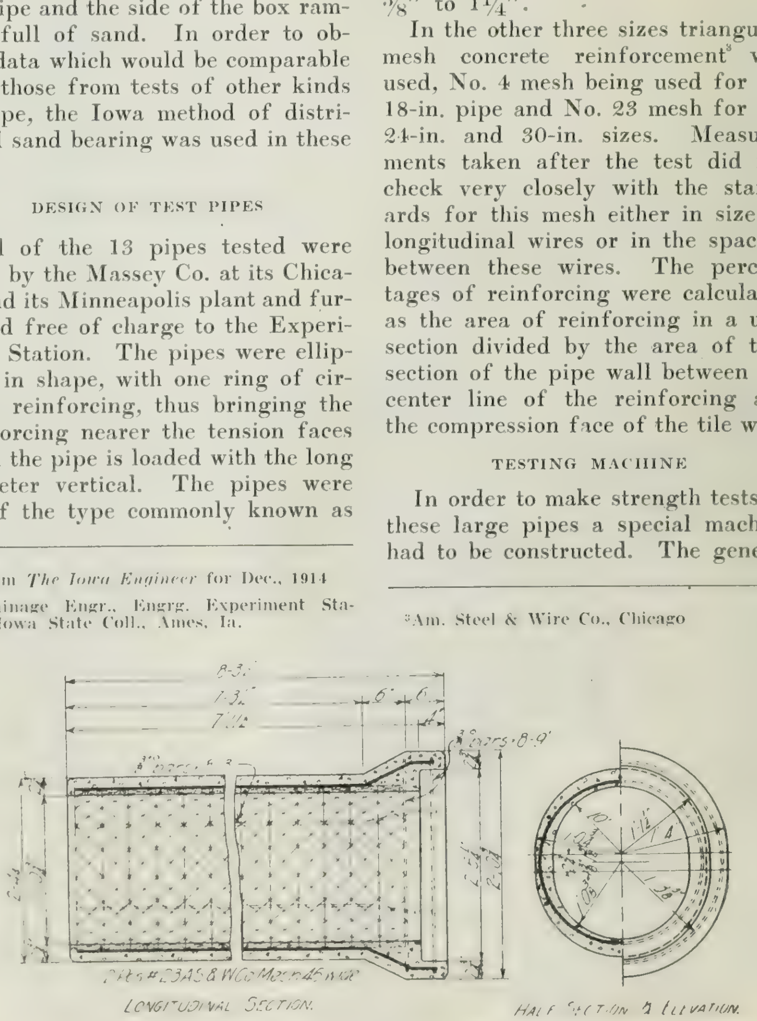

Fig. 1 Standard 23-in. x 20-in. Concrete Culvert Pipe, Showing Wire Mesh Reinforcing

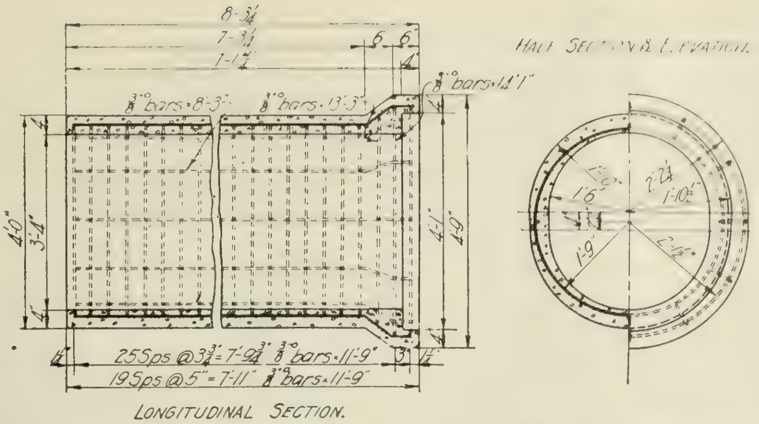

Fig. 2—Standard 40-in. x 36-in. Concrete Culvert Pipe, Showing Steel Bar Reinforcing

features of the machines are shown in Fig. 3. The wooden frame was used simply to support the upper I-beams and the hydraulic jacks while preparing the pipe and the upper sand bearing for the test. The pressure was applied by two (later one) 100-ton, 12-in. runout, independent pump hydraulic jacks through sand bearings over ¼ the circumference of the center line of the pipe wall, using the short diameter and a circular section in calculating this distance. After the first test it was found necessary to reinforce the sides of the sand boxes by running a 1-in. bolt through each sand box. After the first three tests it was found that one jack was sufficient. The machine was accordingly altered so as to bring one set of I-beams over the center of the pipe.

DEFLECTION MEASUREMENTS

Deflection measurements were taken on all pipe when placed in the machine and during the application of the load. The measurements were taken between brass plates, cemented to the pipe wall by means of an Ames dial[4] attached to a micrometer. The changes in both the vertical and the horizontal diameters were obtained, measurements being taken after each increment of the load until the cracking of the pipe displaced the brass plates. The large dial shown on the end of the pipe in Fig. 5 was used as a check on the changes in the horizontal diameter and for measuring the deflections when the pipe was near failure.

The relation of the center of the application of the load to the center of the pipe is shown in Fig. 2. The load was applied in 8-ton increments when two jacks were used and in 4-ton and 2-ton increments when only one jack was used. After each increment of load the deflection measurements were taken and the number and extent of the cracks noted. The loading was continued until no greater load could be obtained upon the jack gauges when the pumps were operated at normal speed.

CHARACTER OF CRACKS

In some respects the manner of cracking of all these pipes was very similar. Usually cracks appeared in either or both top and bottom before they did in the sides. In no case did cracks appear in top, bottom and sides, and in the bell end at the same time. In three cases, Nos. 708, 709 and 713, cracks appeared in top, bottom and sides, in the spigot end, at the same time. In one case, pipe No. 712, cracks appeared in top, bottom and one side in the spigot end at the same time. These facts indicate that

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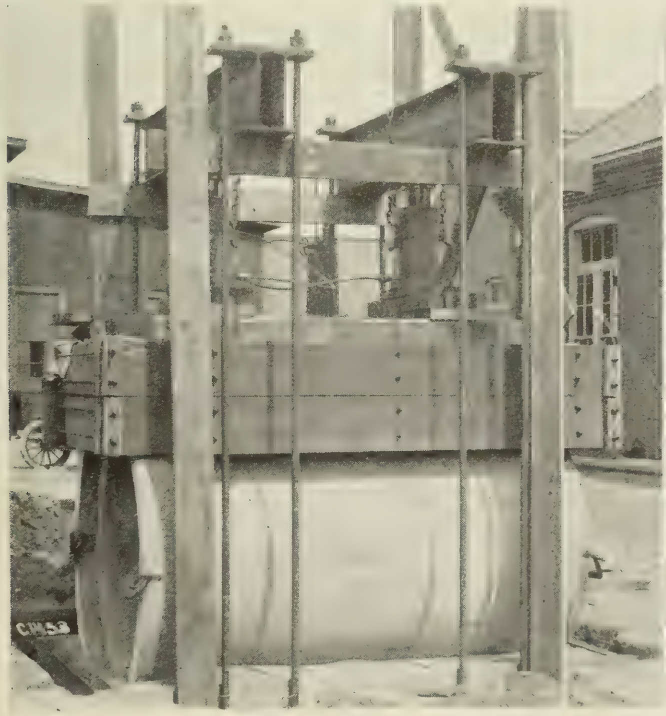
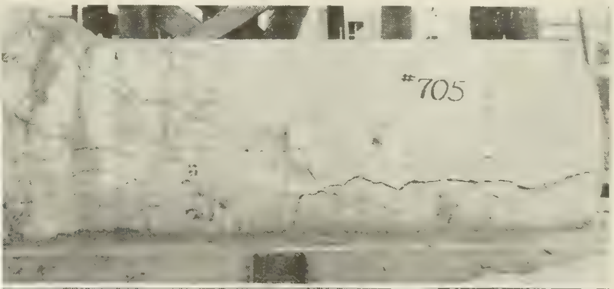
[4] Iowa State College, Ames, Ia.





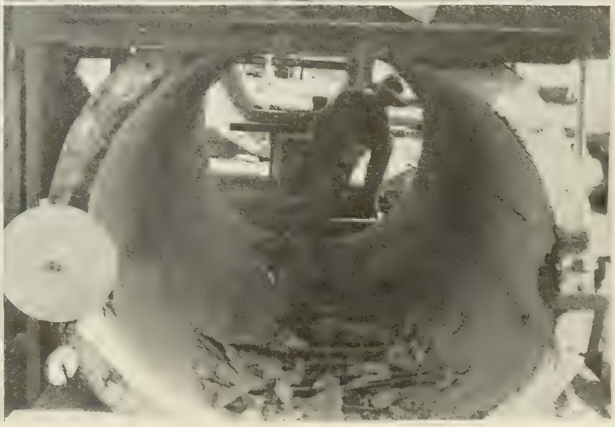


Fig. 3—The Testing Machine and Pipe No. 701 as It Appeared After the Maximum Load Had Been Applied. Note the Location of the Principal Side Failure and the Comparatively Small Number of Cracks in the Side Exposed

Fig. 4—Pipe No. 705 After the Maximum Load, Showing the Typical Manner of Crushing of Mesh Reinforced Pipe. Note the Location of the Principal Side Failure with Reference to the Center Line

Fig. 5—Pipe No. 702 After the Maximum Load Showing the Pulling Out of the Reinforcing and the Crushing at the Compression Faces on the Side. The Crushing Was Never Noted Until, or After, the Maximum Load

the pipes were weaker at the spigot end.

It was interesting to note that, in the bar-reinforced pipes, cracking, especially on the sides, was confined to a few main cracks (see Fig. 3), while in the mesh-reinforced pipes the cracking in the sides was much more distributed and irregular—(see Fig. 4). In all cases the cracking in top and in bottom was confined to a smaller number of cracks than in the sides. In those pipes in which the concrete appeared denser and of better quality the cracking did not start at so low a load, but generally developed more rapidly. There seems to be no fixed relation between the load at which cracking begins and the maximum load.

All difference in the character and number of cracks seems to be traceable to the amount, kind and location of the reinforcing. It has been stated that cracks usually appeared in top and bottom before they did in the sides. This is to be expected when such pipes as these are tested with the distributed sand bearings, as the moments were greater at the top and bottom than at the sides and the reinforcing is less effective. When the pipes are tested the top and bottom portions, also the sides, tend to flatten out, causing a tendency for the reinforcing to pull out of the pipe wall. At the top and the bottom this pulling out tendency is resisted by a comparatively thin layer of concrete (see Fig. 5). The reinforcing in the sides is subjected to the same tendencies but here the pulling out is resisted by a thicker layer of concrete.

The main failure cracks at the sides occurred at some distance above or below the center line and quite close to the point at which the reinforcing crosses the neutral axis of the pipe wall. The point of zero bending moment for a circular ring loaded as in these tests is near the 45-deg. point. In these pipes the reinforcing crosses the neutral axis of the pipe wall at 2½", 5½" and 8½" below and above the 45-deg. point for the 18-in., 30-in., and 48-in. pipe, respectively, or 5", 9" and 14½" above (and below) this point (see Fig. 5).

One pipe was reinforced with corrugated bars, but there was nothing to indicate that this reinforcing was any more effective than the smooth bars. When bell pipes are laid with uncemented joints, a portion of the spigot end of each pipe receives no load. When these same pipes are laid with cemented joints, each end of each pipe is equally rigid and will deflect the same amount. In an effort to approximate both the above conditions and at the same time to adhere to the standard specifications for loading, which requires a full-length loading, the center of the load was placed at a small distance from the center of the pipe toward the bell end. In the 48-in. pipe a loading 4½" off center seemed to give equal deflection. However, these tests were not extensive enough to determine either the effect or the proper distance of off-center loading.

LOAD DEFLECTION CURVES

By observation of the pipe under test and by a study of the collected data it was clearly seen that at some load less than the maximum load a loading was reached beyond which the pipe would be unsafe. There was a decided change in the direction of the load-deflection curves at a load near and usually below half the maximum load. This load, taken from the load-deflection diagrams, was found to come just before the load at which the first full-length crack appeared, except in two cases, where it came just after the load that produced the first full length crack. This load was termed the "Critical Load."

Standard absorption tests were made upon two pieces taken from each tile tested. There seems to be no fixed relation between the absorption and either the critical or the maximum load.

The records of the deflections of these pipes showed that at the critical load the elongation of the horizontal diameter was from .01" to .05", and at the highest load at which it was possible to measure the deflection it was from .04" to 1.2", with an average of from .05" to .75". It is readily seen that for lateral extension of .01" to .05" the ditch filling would not be sufficiently compressed to give any lateral support. This is especially significant when considered in connection with the fact that the critical load was, approximately, the load at which a full length crack was developed.

CONCLUSIONS

As far as this series of tests is concerned, certain points seem to be brought out quite clearly. The pulling out of the reinforcing was usually noticed when the pipes were subjected to a load higher than the critical load, but it seems reasonable to suppose that the bond between the concrete and the steel had been impaired before the pulling out occurred, thus bringing these two loads nearer together. It seems evident that some method of anchoring the reinforcing at the top and the bottom would have made the steel more effective. The development of the principal side cracks so near to the point where the reinforcing crosses the neutral axis indicates that the reinforcing would have been more efficient had it been so located as to cross the neutral axis of the pipe wall at the 45-deg. point. Although no definite turning point was evident during the tests, the data show that the safe load for these pipes was somewhat less than ½ the maximum load.

However, the series of tests is so limited that no general conclusions can be drawn. The above statements are applicable to the specimens tested, but should not be considered as applying to reinforced pipe in general.

Philadelphia is rapidly substituting concrete sewers for brick sewers and for the most substantial of reasons. Referring to the work of sewer building in the Quaker city, George S. Webster, Chf. of the Bur. of Surveys, gives numerous reasons for the use of concrete.

He says: "Concrete absorbs less of the water in the soil than brick, and it is stated that seepage into a sewer system as large as that in Philadelphia amounts to millions of gallons a day." Obviating this seepage, Chief Webster states, will be a material factor in the design of the new sewage disposal plant because excluding the drainage water from the sewer will materially reduce the quantity of sewage to be handled in the disposal plants.

He also states that "concrete pipe is also more economical in some respects. Oval brick sewers, 2' x 3' in diam., require two layers of brick to be substantial, bricklayers are a highly paid class of skilled labor, and their wages add greatly to the cost of brick sewers. Concrete pipe can be made by common laborers in charge of a skilled foreman. The laying of the joints of concrete pipe also is done chiefly by common labor."

Another point which was brought out with reference to concrete sewers is in connection with the wide use of gasoline. Destructive explosions in sewers from waste gasoline which is washed off the streets and from garages are a new danger in large cities. Concrete pipe withstands such explosions better than brick sewers, so the report says.

Do not oil form work after the steel reinforcement has been placed, if as a result of so doing the oil will come in contact with the metal, as this destroys the bond between concrete and steel.

Field Methods in Concrete Construction—Proportioning and Mixing Concrete

By Jerome Cochran, C. E.

The series of articles on field methods in concrete construction, of which this is the second, has been planned in opposition to the general assumption on the part of writers that standards or methods of construction have been long ago established and have become common knowledge. The first article on "Concrete Materials" appeared in this journal for Jan., 1915. The following article relates to the proportioning and mixing of concrete. The next article will be on form work.

PROPORTIONING CONCRETE

With the proper cement, sand, broken stone or gravel selected, the next step is to proportion them properly so as to produce a dense concrete in which the mortar will fill all the voids, and, when rammed in place, free mortar will flush to the surface. The difficulties in arriving at any definite rules for obtaining the maximum density arise from the great variation in the various elements affecting the work, no two materials being exactly alike, and rules deduced from one set of experiments being of very doubtful value when applied to other conditions. Two well established laws, however, govern the theory of proper proportioning, namely:

(1) *With the same percentage of cement in a unit volume of concrete, the strongest and most impermeable concrete is that which has the greatest density.*

(2) *If the sand and stone remain the same, the strongest and most impermeable concrete is that containing the greatest percentage of cement in a unit volume.*

Too much refinement is unnecessary in proportioning materials, as it is impossible to fill all the voids in concrete. The cement and sand cannot be perfectly distributed, and the water used in the mixing causes the sand to swell (increasing the voids about 10%) due to a film of water surrounding the grains that cannot be entirely displaced by the cement. Voids always remain throughout the densest concrete after the water evaporates, and some shrinkage of the mass occurs.

The sand should be well graded from coarse to fine, the coarse particles (not exceeding ¼-in. in size) predominating, so that when mixed with the cement required it will produce a dense and compact mortar. For unimportant work it is sufficient to mix the fine and the coarse aggregates by individual judgment in such relative proportions as will insure maximum density, using correspondingly higher proportions of cement. This is usually done by selecting the proportion of cement to sand which will give the required strength to the concrete, and then use twice as much broken stone or screened gravel as sand. For important work these proportions should be carefully determined by density experiments, and the sizing of the fine and the coarse aggregates should be uniformly maintained, or the proportions changed to meet the varying sizes.

The proportions of cement, sand and stone should be chosen after a very careful study of the local conditions and the available materials.

A very frequent mistake is made in the interpretation of 1:2:4 concrete as equivalent to 1 part of cement and 6 parts of inert aggregate, entirely disregarding the volumetric composition. A typical instance may occur in the substitution of a naturally mixed gravel on work requiring a 1:2:4 mixture, the contractor frequently assuming the liberty of using 6 parts of gravel, governing the interpretation of a 1:2:4 specification as requiring the strength of a 1:2 mortar, when, correctly, gravel should only be used in proportion so as to provide 2 parts of the finer aggregate. In one instance, a contractor insisted that a proportion of 1 of cement to 6 of gravel meant one sack of cement to 6 wheelbarrows of gravel!

In order to secure the necessary strength in pit-run gravel concrete, the cement should be proportioned according to the amount of sand contained in the gravel, sand being defined as that part of the pit-run gravel which will pass through the ¼-in. screen. The relative proportions of sand and stone in the gravel adopted by the Illinois Highway Commission should be such that the volume of sand will not fall below 6/10 of the volume of stone. In gravel, therefore, having a sand to stone ratio greater than 6/10 may be used without modification, but for gravel so used, the cement to sand should be constant for a given class of concrete. In other words, if the volume of sand is found to be less than 60% of the volume of stone, sufficient sand should be added to bring up the proportion of sand to stone to 60%. Should the volume of sand be more than 60% of the volume of stone, sufficient stone should be added to reduce the proportion of sand to stone to 60%, or sufficient cement should be added so that the volume of cement to sand will be for Class "A" concrete as 1:2, for Class "B" concrete as 1:2½, and for Class "C" concrete as 1:3.

The proper proportioning of aggregates should be the occasion for careful experiment, and if the common materials at hand fail, as they will often do, to yield the required density, the deficiency must be supplied by importation of suitable amounts of the size or sizes lacking.

There are four methods in more or less general use in proportioning concrete, which may be designated as follows:

(1) By arbitrary assignment;
(2) By void determination;
(3) By trial; and
(4) By mechanical analysis or sieve analysis curves.

Proportioning by arbitrary assignment consists in assuming the relation of cement, sand and broken stone or gravel as a matter of judgment, or using certain standard proportions, without much, if any, consideration of the character of the aggregate. Unless the character of the materials to be used is known and unless the quality of the concrete made with such a proportion of the ingredients is known, proportioning by arbitrary selection of volume should not be employed, as it is the least scientific method. A 1:2:4 mixture of one contractor may be identical with the 1:2:5 mixture of another, owing to the differences in the sizes of sand and stone. Such a mixture may not contain any more cement than the concrete termed a 1:2:5 mixture by another. Again, if a strong concrete is desired, a proportion of 1:2:4 may be adopted without consideration as to whether or not some other proportion of the same ingredients might give a cheaper and also a stronger concrete. In view of this, it is preferable to give up the old method of specifying mixtures as 1:2:3, 1:2:4, etc., but as 1:5, 1:6, etc., respectively, in which case the 5 or 6 parts of aggregate are mixed up, reducing the voids to whatever figure is necessary for maximum density or strength and then the cement added.

A method more scientific than by arbitrary selection of the proportion is that known as void determination. The latter method, however, is also more objectionable since the percentage of voids in the sand may be greatly affected by a small percentage of moisture, and also owing to possible errors in determining the voids by direct measurement by the use of water. It is, however, simpler, though less scientific, than either of the last two methods mentioned above.

The following method of determining voids may be employed: Fill a watertight barrel, with a plugged hole in the bottom, with broken stone or screened gravel and then pour in water until it overflows; draw the water off in buckets and measure carefully. The quantity of water represents the voids in the coarse aggregates that have been filled with water. On removing the broken stone or gravel from the barrel, pour back the water and mark the level on the side, then draw the water off; fill with sand to the mark and this will determine the amount of sand to be used. Enough water is then poured in to come up to the level of the sand and the amount used indicates how much cement is needed to fill the voids in the sand. To the above proportion of sand and cement add respectively about 10%, and the approximate amount of cement, sand and broken stone or gravel will have been found. Sometimes in addition to adding 10% more cement than the voids in the sand, 10% more sand than the voids in the broken stone or gravel is added to provide for inaccuracies in measuring the voids.

In proportioning by trial mixtures the proper proportions of sand and broken stone or gravel may be determined by finding what mixture has the maximum weight for a given volume, as follows: Several batches of different proportions should be carefully mixed, and placed in an ordinary galvanized iron pail, using a full pail of materials in each instance, as small batches are likely to prove deceptive. The material should not be rammed into the pail, as it is almost impossible to ram twice alike. Instead, fill the pail about half full of water and sprinkle the mixture of cement, sand and coarse aggregates into it slowly from a shovel. The pail should be filled in each instance, allowing the excess of water to run over the edge. The combination of proportions having maximum weight should be used for all classes of concrete, using less cement for porous mixtures. It should be remembered that each batch of concrete must be weighed and taken out of the pail before it has time to set, otherwise, some difficulty might be experienced in getting it loose.

Proportioning by sieve analysis is the most exact and effective method of studying the character of the aggregate, and of calculating the effects of various mixtures. This method was devised by Wm. B. Fuller, and is described by him in considerable detail on pp. 183-215 of Taylor & Thompson's "Treatise on Plain and Reinforced Concrete" (1909 edition), to which the reader is referred, and also to Ira O. Baker's "Masonry Construction," pp. 147-154 (1909 edition). Proportioning by sieve analysis consists in separating the available materials, excluding the cement, into various sizes by means of a series of sieves, and the results plotted on cross-section paper, the percentage by weight passing each size sieve being used as abscissae, and the size as ordinates. Curves thus plotted indicate the percentages of the whole mass that passes the several sieves. A straight line indicates a uniform grading of size. The following sizes of screens are desirable, although a very useful analysis may be made with fewer screens: 3 -in., 2¼-in., 1½-in., 1-in., ¾-in., ½-in. and ¼-in.

UNITS OF MEASUREMENT

Concrete should as a rule be proportioned by weight. The most common method, however, is measurement by volume. When using the wheelbarrow as a unit of measurement it should be definitely understood: (1) whether the volume of cement used is as volume measured loose or as volume as packed in the wheelbarrow; (2) what the cubical contents of a wheelbarrow of cement shall be called. It is usually customary to assume a bbl. of packed Portland cement to be 2.8 cu. ft.; the volume, however, may range from 3.2 cu. ft. to 4 cu. ft. A bag of cement is assumed to contain 1 cu. ft.

If the materials are measured in wheelbarrows it should be definitely understood what the volume of a wheelbarrow will be called. There is a cu. ft. difference between the capacity of a wheelbarrow, water measure, and the load usually carried by men in wheeling.

MEASUREMENT OF MATERIALS

An approximate method of measuring material should not be used which would yield an excess of sand and broken stone or gravel over cement. The usual course of providing a struck wheelbarrow of cement and heaping wheelbarrows of sand and broken stone or gravel must not be permitted.

Concrete materials may be measured in bottomless boxes or headless cement barrels, by a properly constructed double gate in a bin chute; by the use of suitable carts; by wheelbarrows having square or cylindrical bodies expressly designed for this purpose; or by automatic measuring devies. When measuring by weight, the scale should be set at a weight which is a fraction of the total weight.

Accurate measurements are of great importance and require (1) that definite measuring units be employed; (2) that the accuracy of the measuring boxes be verified; (3) that the filling of the measuring boxes, hoppers, etc., be exact; and (4) that when two or more boxes or hopperfuls, etc., go to make up a batch, the exact number is employed for each and every batch.

MIXING CONCRETE

Concrete may be mixed either by hand or by machine, both of which, if properly applied, give about the same grade of concrete. However, the work done by hand is likely to be uneven in quality and some batches will be more thoroughly mixed than others. Machine-mixed concrete, on the other hand, is usually of more uniform quality and is generally less expensive than hand-mixed concrete. Hand mixing should be employed only when the quantity is small or when machinery is unobtainable.

During the mixing of the concrete, the inspector should (1) count the bags of cement; (2) see that the measurements are exact; (3) see that the mixer runs long enough; (4) see that the amount of water is so regulated as to produce the desired consistency or fluidity; (5) see that no foreign substances, such as shavings, chips, blocks of wood, etc., have found their way into the mixture; (6) see that the lumps of hard cement are compensated for with good cement; (7) see that the proper proportions have been used; (8) see that the concrete is thoroughly mixed—that is, uniform: that it has not balled in the mixer, etc.; (9) see that the mixer is cleaned before starting; (10) see that the materials are running uniform, regular in size, and not mixed with dirt, no single wheelbarrow composed entirely of large stone or of small stone, etc; and (11) see that the proper care is taken in dumping the concrete in place.

The proper amounts of ingredients should preferably be emptied into the charging box of a batch mixer in the following order; (1) sand; (2) cement; (3) broken stone or gravel; (4) water, the water being so regulated as to produce a concrete of the desired consistency. It is better to mix the materials in a dry state at first, and then gradually add the water in a spray and continue the mixing. It makes very little difference as to the order in which the materials are entered in the mixer, except that the water should be added last.

If the continuous mixer is used, careful watch should be kept of the cement hopper, as the cement is liable to run low, feeding only a portion of the worm, or a large lump of cement may ride on top of the worm and hinder the feed; or the worm may become coated with damp cement, which reduces its capacity. If the inspector watches the cement hopper, the contractor will attend to the sand hopper and the stone hopper.

In mixing concrete by machine, the important points to be observed are:

(1) That the directions supplied by the manufacturer are carefully followed.

(2) That the pecified proportions of the ingredients are fed into the mixer at all times. The entire amount of cement must be added to the other aggregates before mixing is begun, and the whole should be mixed dry before the water is added. In machine mixing, all the materials, including the water, are sometimes introduced at once without intermediate mixing, but better results are likely to be secured, even with machine mixers, by first mixing the materials dry.

(3) That the quantity of water is uniform and of proper amount to produce the desired consistency. Machine mixing should be carefully studied until one knows exactly how much water may be used.

(4) That the ingredients are thoroughly incorporated before leaving the mixer. Look out for dirty, soft stone and sand and for lack of uniformity in the product of the mixer.

(5) That the entire contents of the mixer are taken out at each emptying.

(6) When the mixer is stopped it should be flushed with water and no concrete, partially set or otherwise, should be permitted to remain in it.

(7) In feeding a continuous mixer by shovel, see that all of the material is fed at the loading end. It is not uncommon to see at least one of the shovel men feeding his material at the dumping end.

In hand mixing emphasis should be placed upon (1) the exact measurement of the broken stone or gravel; (2) thorough mixture of the cement and sand; (3) thorough mixture of the mass, and (4) the proper amount of water to produce the desired consistency.

The sand and cement should be turned at least 3 times dry and 3 times wet, and the mortar and stone then turned 3 times. Material turned less than 3 times after it has been wet can not be considered as well mixed. The order of turning should be so regulated that the last turn made will place the material in a single pile at the center of the board, preparatory to its removal to the place for it in the work.

Design Methods in Concrete Construction—Graphical Statics of Simple Beams

By Jerome Cochran, C. E.

This is the second of a series of articles on design methods in concrete construction. The first article, published in Concrete-Cement Age *for Jan., 1915, was devoted to analytical statics of simple beams. The present article will be devoted to the fundamental principles of graphical statics or equilibrium of forces as applied to external moments for simple beams, such as reactions for supports and bending moments, because a very thorough understanding of these principles is an essential preliminary to scientific reinforced concrete designing. The next article will consider the design of reinforced concrete beams.*

Graphical statics relates to the solution of statical problems by geometrical constructions or diagrams in which the lengths and directions of the lines represent, respectively, the magnitudes and the directions of the forces treated. In short, graphical statics treats of the geometrical or graphical analysis of balanced forces.

THE GRAPHICAL REPRESENTATION OF FORCES

In the geometrical solution of mechanical problems every force, which is an action upon a body tending to change its state of rest or motion, can be conveniently represented by a straight line that either coincides with, or is parallel to, the line of action of the force. A force is completely known where its magnitude, direction, line of action and point of application are known.

The *magnitude* of a force can be represented graphically by the length of a line, the length being drawn to a previously chosen scale, for instance, if the scale is 1″ = 10,000 lbs. then a line ¾″ long represents a force of 7,500 lbs. A decimally divided scale, i. e., a scale of 10, 20, 30, 40 or 50 divisions to the inch, is the most convenient to use in representing forces. The larger the scale, the more accurate are the results.

The *direction of the force* is indicated by the arrow-head pointing in the direction in which the force tends to move its point of application. The arrow-head shows the "sense" of the force. By *sense* is to be understood the specification as to which of the two ways along the line of action the force tends.

The *line of action* is along the line representing the force and it is along this line that the force tends to produce motion.

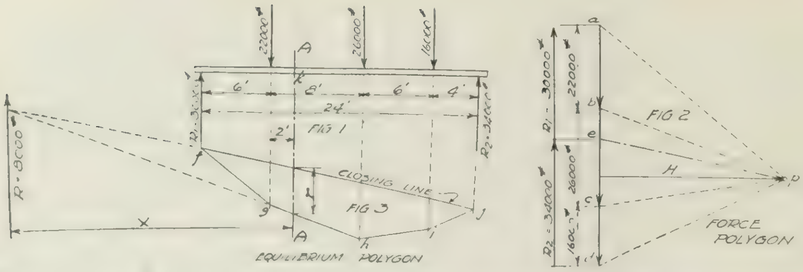
The *point of application* is the place assumed as a point at which the force acts upon the body. It is usually considered to be at one end of the line representing the force, although in the case of rigid bodies any point whatever on the line of action of the force may be taken as the point of application. Change in the point of application of a given force affects the body as to rotation only, not at all as to translation.

In dealing with problems in statics of rigid bodies, the *magnitude, direction* and *line of action* of a force are the elements commonly involved, since the equilibrium or motion of such a body is not affected by transferring the point of application of a force to any other point in its line of action.

The graphical method of representing forces is made very valuable by the fact that the relations necessary to the condition of equilibrium between the forces so represented can be determined by applying the principles of geometry to the lines so used. A combination of forces may thus be analyzed.

REACTIONS OF A SIMPLE BEAM DETERMINED GRAPHICALLY

The reactions R_1 and R_2 of the beam shown in Fig. 1 due to the



Figs. 1, 2 and 3—Sketches Illustrating the Application of the Force and Equilibrium Polygons for Determining the Reactions and Bending Moments as Applied to Simple Beams with Parallel Forces in the Same Plane

three concentrated vertical loads may readily be determined by means of the force and equilibrium polygons, the force polygon being needed to find the magnitude and the direction of the resultant or the single force that would produce the same effect as the other forces. The weight of the beam itself is not considered. The length of the span and all distances are shown in the figure.

Draw the line *ad* to represent the sum of the loads (64,000 lbs.) on a suitable scale, say 1″ = 10,000 lbs., and divide *ad* into segments *ab, bc* and *cd*, representing respectively the given loads 22,000 lbs., 26,000 lbs. and 16,000 lbs.

Select a convenient pole *p*, such that the distance from *p* perpendicular to *ad* (called *pole-distance*) represents on the same scale an even number of units of force. The pole-distance is marked *H*, which is its usual designation. It is to be noted that this distance represents a force magnitude.

The strings or rays *pa, pb, pc* and *pd* (Fig. 2) are now drawn. Select some point *n* on the line of action of R_1, and draw the line *fg, gh, hi* and *ij* (Fig. 3) parallel to the rays *pa, pb, pc* and *pd* respectively. Connect the points *f* and *j* in Fig. 3, giving the closing side *fj* of the equilibrium polygon *fghij*. Draw *pe* in the force polygon (Fig. 2) parallel to the closing side *fj*, thus determining the point *e*. Then *de* and *ea* are the two reactions R_2 and R_1 respectively, which acting upwards close the force polygon. $R_2 = 34{,}000$ lbs. and $R_1 = 30{,}000$ lbs.

Fig. 2 is the force polygon, while Fig. 3 is the equilibrium polygon. The difference between these two polygons should be carefully noted. The force polygon, sometimes called a magnitude polygon, gives the direction and the magnitude of the forces, while the equilibrium polygon, sometimes called a funicular polygon, gives the lines of action and the direction but not the magnitude.

As the pole *p* may be taken anywhere, any number of force polygons, and consequently, any number of equilibrium polygons, may be drawn, each of which will give the same value and locate the same line of action for the equilibrant (or for the resultant). To test the accuracy of the work, take a new position of the pole and proceed as before. The larger the scale used, the more accurate will be the results. In selecting the pole, the matter of obtaining accurate and convenient diagrams should be kept in view. Generally the rays should not make very oblique angles with the adjacent lines of the force polygon.

In treating uniform loads graphically it is necessary to divide the load into small sections and the load corresponding to each section is considered at its center.

GRAPHICAL EXPRESSION FOR MOMENTS

The moment of a single force about any point may be expressed and determined graphically in the following manner:

Let the force F = 1,000 lbs., shown in Fig. 4, tend to cause rotation about the point *o* as a center. The lever arm of the moment is *fo* = 10′.

It is desired to ascertain the moment of *F* about *o*.

Draw *ab* parallel to E and equal to 1,000 lbs. to any convenient scale, as shown in Fig. 5. Choose any point *p* as the pole, and draw the strings or rays *pa* and *pb;* also draw *pc* perpendicular to *ab*. Through any point, as *x* on F, draw the lines *xd* and *xe* parallel, respectively, to *pa* and *pb;* the lines *xd* and *xe* correspond to the sides of an equilibrium polygon, through the intersection of which the resultant must pass; the force F, in the present case, corresponds to the result. Prolong *dx*, and through *o* draw *og* parallel to *F*, intersecting *xe* and *dx* in *g* and *h*. By geometry it can be shown that

$$ab \times fo = gh \times cp, \text{ or as}$$

$ab = F$ and $F \times fo$ is the moment of *F* about *o*, the moment of *F* about $o = gh \times cp$, if *gh* is measured to the same scale used for *fo*, and *cp* is measured to the same scale used for *ab*.

The line *gh*, which is intercepted between the two lines which meet upon the line of action of the force (one line, as *xd*, being prolonged if necessary) is called the *intercept*.

The principle explained above is one of the most important facts in graphic statics, and may be briefly stated as follows:

The moment of a force about any point equals the intercept with respect to that point multiplied by the pole distance.

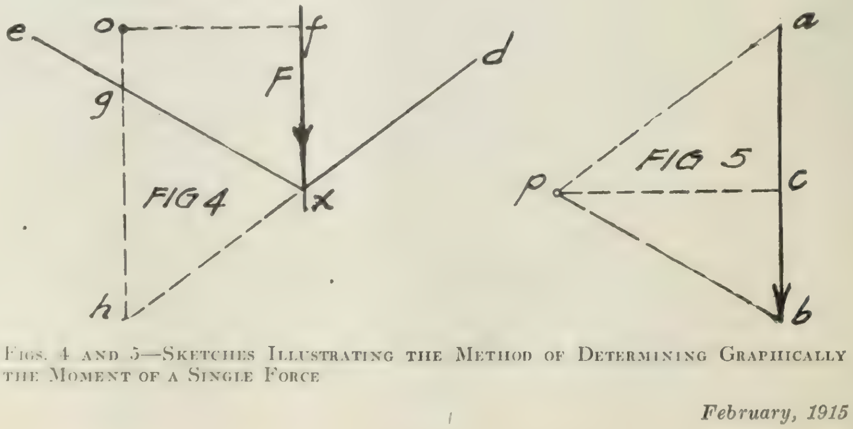
The principle is equivalent to the algebraic statement mentioned in the first article of this series, i. e., *Moment* = Force × Perpendicular.

Since, in Fig. 4, but one force *F* is represented, it is evident that, in this figure, the equilibrium polygon is not complete; for the action of a single force cannot produce a condition of equilibrium. The lines *xd* and *xe*, however, may be any two lines of the equilibrium polygon which intersect upon the line of action of the force.

If the above principle be applied to the resultant of any number of force, it will give the resultant moment of all the forces about any given point; for the moment of the resultant of the given forces about any point will equal the resultant moment of the same forces about the same point as will be shown by the following example:

MOMENT OF A SIMPLE BEAM DETERMINED GRAPHICALLY

Let the bending moment *M* be required at any section of the beam



Figs. 4 and 5—Sketches Illustrating the Method of Determining Graphically the Moment of a Single Force shown in Fig. 1, such as k. By bending moment or simply the moment on any beam section is meant the algebraic sum of the moments to the left of that section. It is also equal to the sum of the moments of the forces to the right of the section.

The equilibrium polygon already constructed for the reactions of this beam may be used to determine the moment of any or all of a system of parallel forces. Draw a vertical line AA through the section, cutting the sides fj and gh of the eqilibrium polygon (Fig. 3), and let the ordinate intercepted between these sides be called r. The intersection of these sides produced gives the point of application of the resultant of the 22,000-lb. load and the reaction R_1 (30,000 lbs.) the magnitude of which is represented by eb in the force polygon (Fig. 2); that is, $ae - ab = eb \doteq 30{,}000$ lbs. — 22,000 lbs. = 8,000 lbs. It should be noticed that the reaction $R_1 =$ 30,000 lbs. and the 22,000-lb. load act in opposite directions and, consequently, the resultant of these two forces is their difference. Let this resultant be called R and its horizontal distance from k equal x. Expressed algebraically the bending moment at AA equals

$$M = R\,x$$

The triangle obe (Fig. 2) is similar to the triangle which has a base r and an altitude x (sides respectively parallel) in Fig. 3 and, since eb is equal to R, we have

$$\frac{x}{H} = \frac{r}{R} \text{ or } Rx = Hr$$

Therefore, the bending moment of the forces on the left of the section is

$$M = Hr$$

Since H is constant (due to all loads being vertical) the bending moment at any point in the span is proportional to the vertical ordinate of the equilibrium polygon at that point.

Suppose in the equilibrium polygon (Fig. 3) $3/16'' = 1$ ft., and $H = 48{,}000$ lbs., then $3/16''$ in the equilibrium polygon represents 48,000 lbs.-ft. That is, each inch on the vertical ordinate of the equilibrium polygon represents 256,000 lbs.-ft. of bending moment. For instance, the vertical ordinate at the section AA scales $0.765''$ and the bending moment of this section, under the above conditions is $256{,}000 \text{ lbs.} \times 0.765'' = 195{,}840$ lbs.-ft. The moment by an algebraic equation is 196,000 lbs.-ft.

The bending moment at any point on a beam due to a system of parallel forces is equal to the ordinate of the equilibrium polygon (see Fig. 3), cut off by a line drawn through the given point and parallel to the resultant of all the forces multiplied by the pole distance H (see Fig. 2). The intercept in the equilibrium polygon is a distance and should be measured to the same scale as that to which the beam is laid off. The pole distance H is a force and should be measured by the scale used in the force polygon. In other words, *measure* the forces and other *vertical distances with the scale of force* (in pounds) and all *horizontal distances with the scale of space* (in feet). Thus, r, ab, bc, etc., should be measured in pounds and x, H, etc., in feet.

Where beams are uniformly loaded, it is somewhat difficult to represent graphically the bending moment at every point in the span, and the algebraic method described in the last article is much simpler. A combination of algebraic and graphic methods may be used when a beam is subjected to both uniform and concentrated loads, the former method being used for finding the bending moment for the uniform load and the latter method for the bending moment due to concentrated loads. The algebraic sum of the two moments at any given section will give the correct moment at that section.

Early Reinforced Concrete in England

In thinking of reinforced concrete one usually gives the credit of priority of use to Jean Monier, the Frenchman, whose system came into use about 1876. But Dr. Fritz von Emperger, Vienna, in some research work, has found mention of a reinforced concrete beam designed by G. Brunel, architect of the first Thames tunnel, as long ago as 1835. An illustration of the beam and a brief description follow, taken from *Le Ciment Armé*, Paris.

What was the first resistance test of the adhesion of reinforced concrete and why did our modern material not come into use half a century earlier? Dr. Fritz von Emperger makes these matters clear. The distinguished director of *Beton und Eisen*, in the course of some historical studies, found in an article published in the *Allgemeine Bauzeitung* (Vienna) in 1838 a detailed description of a test undertaken by G. *Brunel*, the engineer, in 1835, at the Institute of English architects, on a reinforced beam, shown in Fig. 1.

This test, which was made the subject of a report signed by the great engineer to whom is due the first tunnel under the Thames, had for its object the determination of the adherence of concrete to iron. It was planned to construct an arched gallery leading to this celebrated tunnel, which would have been the first work of this kind in reinforced concrete. The cement used was Roman Vauxhall. The first application of test load was made two months after the beam was fabricated, using pig-iron. The load was removed a year later; the first crack showed under a load of 5 tons and the beam failed under a weight of 18 tons.[1]

Dr. von Emperger adds a note that Gen. Pasley has mentioned the details of the same test in his book, "Limes, Cements and Plasters." The figure does not show how the 12 rods were placed. This has little importance, in any event, for the most curious thing in connection with the matter is that the designer, not being satisfied with the results obtained and fearing the future effect of oxidation on the rods used for reinforcing, probably in the joints of the masonry, decided to use reinforcing members of wood treated with tar.

The greatest intellects may thus pass by the truth, through some accident, when chance, the important factor in invention, opens wide the door of fortune and success. It is recalled that Napoleon declined to interest himself in the first plan for a boat propelled by steam.

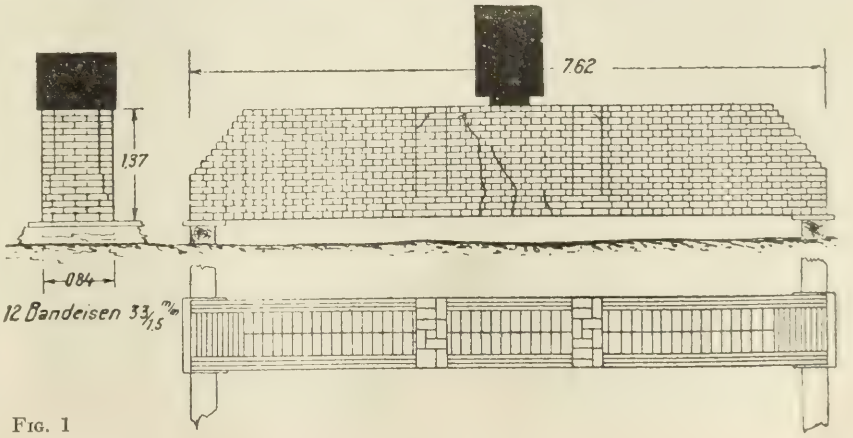


FIG. 1

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[1] The span was 7.62 m., depth 1.37 m. and thickness 0.84 m., with 12 iron rods—EDITORS

Methods and Costs of Providing Slopes for Drainage on Flat Concrete Roofs

By Albert M. Wolf, C. E.[1]

Where concrete roofs are made flat in order to provide a flat ceiling without the use of a suspended ceiling, or when a future floor is used as a temporary roof, some construction must be placed on the concrete slab to provide for drainage. The intention is to describe in detail, with costs, several methods of providing drainage on flat concrete roofs.

CINDER FILL

A cinder fill placed on the roof in such a manner as to drain it properly is most commonly used for this work. Such construction has not in all cases given satisfactory results, but, like most other things, it is not fool-proof and if not properly carried out the best results cannot be expected. In altogether too many cases the cinders, no matter of what quality or how badly mixed with refuse, are very carelessly placed, and in some cases with altogether too great a depth, on account of improper downspout locations. Then, when the roof is a failure, "cinders" and not the architect and builder are blamed and cinder fills are henceforth "tabooed" as a poor method of obtaining roof drainage.

A little care exercised in selecting and grading cinders to be used for such work and also in placing them, puts an altogether different complexion on the matter. It cannot be too firmly impressed on the architectural designer and builder that careful work is just as essential to make this common method a success, as it is in order to construct, for instance, a good tar and gravel roof. Some men have the idea that any gang of laborers can *without* careful superintendence, construct a satisfactory cinder fill, simply because the material happens to be cinders, or closely allied to dirt, which any man can handle simply by brawn unmixed with brain. It is this same sort of stolid indifference which brings into disrepute many types of construction, which, if properly handled, are a success.

The cinders used for a cinder fill should be of a porous grade of screened steam boiler cinders, free from refuse or slag, which only add unnecessary weight to the fill. Cinders mixed with fire brick, unburned coke, slag and similar refuse should not be used, since the prime advantage of cinders as a fill is their relative light weight, and if this rule is not obeyed crushed stone might as well be used.

The cinders should be wet down thoroughly, then placed on the roof and arranged to form the proper slopes and tamped to an even surface, a little more water being sprayed upon the surface if necessary, to compact the fill thoroughly. The minimum thickness of any place should not be less than 3″, in order to obtain the best results. After a portion of the roof has been covered with cinders, as prescribed above, and before they have dried out entirely, a mortar coating about 1″ thick, composed of 1 part cement and 3 parts clean sand, mixed quite wet, should be placed on the cinders and given a smooth float finish. The mortar being mixed wet, some of it will seep into the cinders and as a result its top surface becomes a cinder concrete, making the total thickness of the mortar coat somewhat more than 1″. After the mortar has thoroughly set the roofing should be applied.

When placing the top portion of the cinder fill and the mortar finish it should be kept an inch or two from all parapet walls to provide for expansion; this space to be filled with some bituminous or asphalt paving pitch which becomes soft under the sun and very readily allows for expansion. Fig. 1 shows a cross-section of a concrete roof with a cinder fill for drainage.

While placing and tamping the cinders, 1-in. or 2-in. boards side by side can be placed against all walls and parapets, extending into the fill for a few inches and the cement mortar coat placed against them. After the mortar has set the boards should be removed and pitch should be poured into the joint.

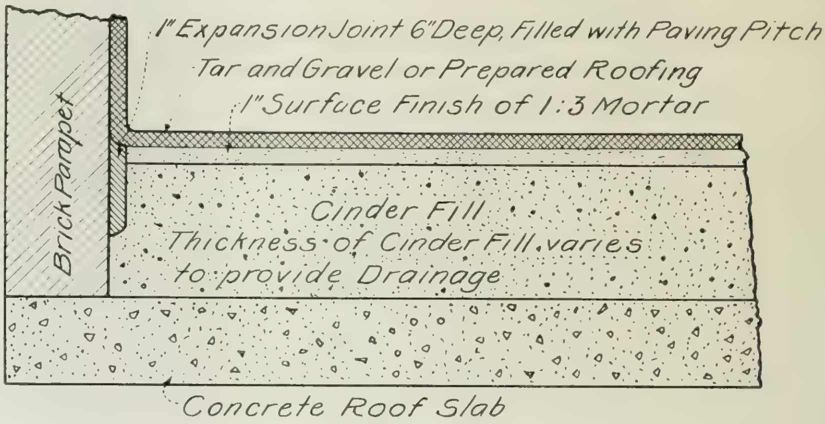
1″ Expansion Joint 6″ Deep, Filled with Paving Pitch
Tar and Gravel or Prepared Roofing
1″ Surface Finish of 1:3 Mortar
Brick Parapet
Cinder Fill
Thickness of Cinder Fill varies to provide Drainage
Concrete Roof Slab

Fig. 1—Details of Cinder Fill on Concrete Roof Slab for Drainage

The weight of cinder fill construction as here described, will vary from 65 lbs. to 75 lbs. per sq. ft. for a depth of 1′, depending upon the grade of cinders used. The actual weight of fill at various points on the roof will, however, vary considerably on account of the slopes. If downspouts are properly located the average depth of fill required should be but little over 12″, thus allowing for a maximum depth of 21″ and a minimum of 3″. At a slope of 3/8″ per ft. this depth would be sufficient to provide for drainage 48′ each way from the downspout. To have much more area than this tributary to one downspout cannot be considered good design, since there is too much danger of serious trouble should the downspout become clogged. It should be borne in mind that it is cheaper to supply more downspouts than to overload the roof slab with cinders to care for the deficiency. When too great a depth of cinders is used the concrete roof, which must be designed to carry the load, will be unnecessarily heavy and costly, and consequently uneconomical. It should be remembered when designing concrete roofs which are to carry cinder fills, that it is highly important that the weight of fill and roofing be taken into account in the calculations. Too many designers ignore this weight in design, assuming that the assumed live load will care for this extra dead weight, which is far from being the case.

When a cinder fill is used for

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[1] Asst. Engr., Condron Co., Structural Engrs., Chicago

drainage, it is of the utmost importance that a good roofing be used on it, for if leaks occur in the covering the fill becomes saturated and, besides overloading the slab, may seep through the concrete and cause no end of trouble.

It often happens that concrete buildings are planned for future additional stories by designing the columns and footings to care for these additional loads. In this case one of the floor slabs—designed as such—acts as the temporary roof and an auxiliary construction must be used to provide for the drainage. For such conditions a cinder fill will in general prove most economical, for when additional stories are built the fill can be broken up and practically all of it used again in forming slopes on the new roof. This cannot be so readily done with the other constructions described herein.

In most localities cinders of a suitable grade can be obtained very cheaply and it will therefore be found that the main items in the cost of a cinder fill are the labor cost of hoisting and placing on the roof and the cost of the mortar finish. If the haul is not very great cinders should not cost much over 15 cts. per cu. yd. —in this case the total cost of a cinder fill as herein specified will be 9 cts. or 10 cts. per sq. ft. for fills averaging 12″ deep. About one-half of this amount can be charged to the cement mortar finish.

CINDER CONCRETE FILL

Another way of obtaining slopes for drainage on flat concrete roofs is by the use of cinder concrete fills. The great objection to this material for this use is its excessive weight, viz; 100 lbs. to 110 lbs. per cu. ft. This extra dead load, more than three times the live load usually used in design—30 lbs. per sq. ft.—very rapidly increases the cost of the roof construction, which must be much heavier in order to carry the load.

Cinder concrete for this work should be a very lean mixture, in general 1 part by volume of cement and from 8 parts to 10 parts of well screened, spongy and porous steam boiler cinders, with just enough water added to make a rather dry and porous concrete. This mixture should then be placed to the required slopes with a minimum thickness of 3″ in such a manner as to preserve, as much as possible, the porosity. A 1:3 cement mortar coat about ¾″ thick should be put on and floated to a uniform surface before the fill has set, to form a smooth surface upon which the roofing can be applied.

Cinder concrete expands a relatively large amount on warm summer days and it is therefore of the greatest importance to provide good expansion joints at all walls and parapets, to prevent them from being pushed out of line. When placing the cinder concrete a space at least 1″ wide, extending the entire depth of the fill, should be left at all walls, this space to be filled with a bituminous or asphaltic pitch. Even with these precautions exercised there is danger of excessive expansion and pushing walls out of line and for this reason, also on account of its excessive weight, cinder concrete fills are not recommended to afford drainage.

A cinder concrete fill as herein specified with an average depth of 1′ will cost from 12 cts. to 15 cts. per sq. ft. in place, depending on cost of cinders and the method of hoisting into place.

Cinder concrete fills should not be used on temporary roofs, for when the building is extended the concrete must be broken up and cannot be used again in this condition. This means that new material must be provided, since there is no salvage as is the case with a cinder fill.

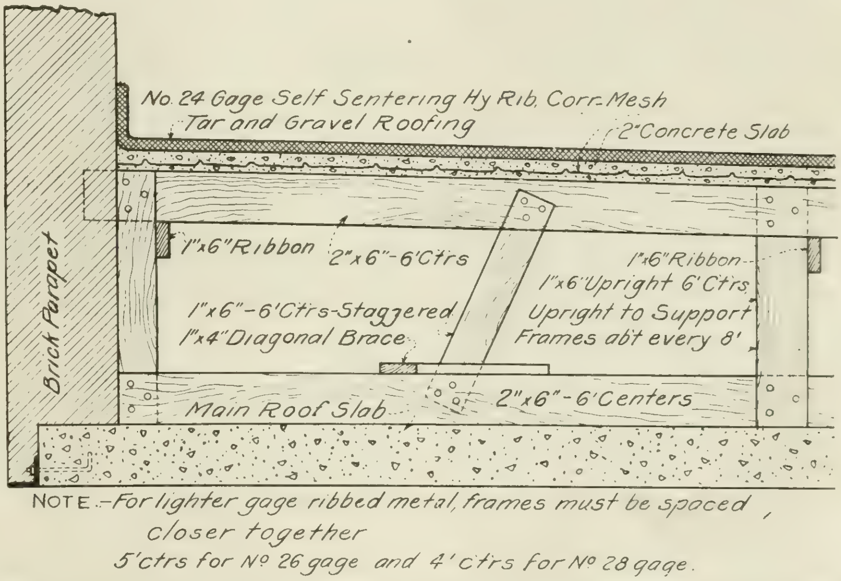
No. 24 Gage Self Sentering Hy Rib, Corr-Mesh
Tar and Gravel Roofing
2″ Concrete Slab
1″x6″ Ribbon
2″x6″-6′ Ctrs
1″x6″ Ribbon
1″x6′ Upright 6′ Ctrs
Upright to Support Frames abt every 8′
1″x6″-6′ Ctrs-Staggered
1″x4″ Diagonal Brace
Brick Parapet
Main Roof Slab
2″x6″-6′ Centers
NOTE.-For lighter gage ribbed metal, frames must be spaced, closer together
5′ ctrs for Nº 26 gage and 4′ c'trs for Nº 28 gage.

Fig. 2—Details of Secondary Roof of Concrete for Drainage of Flat Concrete Roof

SECONDARY ROOF OF WOOD COSTRUCTION

Sometimes slopes are provided by a secondary roof of wooden construction, consisting of light wood frames of 2-in. by 4-in. stuff placed from 2′ to 3′ apart, covered with sheathing and the roof placed thereon. The weight of this construction is only about 10 lbs. or 12 lbs. per sq. ft., not including the roofing. Although it has the advantage of very light weight, this construction is not fireproof and will decay and rot out in a short time if leaks occur in the roofing. These disadvantages, coupled with the fact that it is not in accordance with the Underwriters' classification for fireproof buildings, are responsible for its not being used extensively.

SECONDARY ROOF OF CONCRETE

A new type of construction of a nature somewhat similar to that just described consists of a secondary thin concrete slab on stiffened metal lath supported on wooden frames, resting on the main roof slab. These frames consist of 2-in. by 6-in. stringers placed on edge on the roof slab supporting rafters of the same size directly above, at the required slope, by means of short struts. If a No. 24 gauge stiffened metal lath, such as Hy-Rib,[2] Corr-Mesh[3] or Self-Sentering,[4] is used on these frames to support a 2-in. concrete slab and act as reinforcement. The frames may be placed about 6′ o. c. and should be braced by transverse and diagonal boards so as to keep them in line and upright.

The stiffened metal lath should be securely fastened to the frames with the ribs at right angles to them, and lapped at sides and ends over supports. It is very important that all laps be securely tied and wired so as to have the entire covering of metal as rigid as possible, on account of the thin slab used.

The concrete placed on this mesh should be of a 1:2:4 or 1:1½:3 mixture, or as dense as possible, thoroughly mixed and rather dry so that it will not seep through the mesh which acts as the form surface as well as reinforcement. The coarse aggregate used should be crushed stone that will pass a ¾-in. mesh sieve. After placing the concrete to a thickness of 2″, which, after hardening, will support a live load of from 25 lbs. to 30 lbs. per sq. ft., it should be given a smooth float finish to receive the roofing. (See Fig. 2.)

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[2] Trussed Concrete Steel Co., Youngstown, Ohio

[3] Corrugated Bar Co., Buffalo

[4] General Fireproofing Co., Youngstown, Ohio

The roofing applied should be of the best quality, carefully applied so as to prevent any moisture from reaching the metal reinforcement which is unprotected on the bottom. If it does the mesh will soon rust out, the timber decay and the roof be destroyed.

The disadvantages of this construction are that it is not strictly fireproof and it is rather costly, the average cost, not including roofing, being about 16 cts. per sq. ft. It is, however, comparatively light, weighing from 30 lbs. to 32 lbs. per sq. ft. This construction eliminates the uneven loading to be contended with where cinder fills and cinder concrete fills are used.

CONCLUSIONS

Just which type of construction for roof drainage will best suit the requirements depends mostly on the location. Where good cinders are available and the roof construction is temporary (resting on a future floor designed for a heavier load than that of the fill) the cinder fill will be the most satisfactory and economical type, all things considered. If the roof slab is designed as such, and laid without slope, a considerable amount can be saved in its construction by the use of a secondary roof of concrete construction as shown in Fig. 2, which is much lighter than a cinder fill; or stated more exactly, weighs from 20 lbs. to 25 lbs. less than a fill 1′ deep. On a large roof area the secondary roof of concrete on wooden frames would no doubt prove to be just about as cheap as a cinder fill because of the lighter main roof construction required.

The matter of insulation of the roof slab against condensation has not been treated in this article, but forms an important part of the consideration as to which type of construction to use for drainage of a flat concrete roof.

A discussion of the advantages and disadvantages of the various types of insulation for concrete roofs was given in an article by the writer appearing on page 241 of the May, 1914, issue of CONCRETE-CEMENT AGE, to which the reader is referred.

So far as insulating properties are concerned, the cinder fill and the secondary roof of concrete are about on a par and since in general the cost of a cinder fill is less than the latter it has justly been the most popular method of providing drainage slopes on flat concrete roofs.

Wall Beam Details In Reinforced Concrete Building

In reinforced concrete building design it is becoming common practice to put the wall beams above the floor slab in order to let in as much light as possible as close to the ceiling.

In a recent address and in discussing this subject, L. C. Wason, Boston, says that it is generally cheaper and equally good construction to cast the wall beam as a separate operation, allowing the ends to rest in rebates in the columns and suspending the slab below by means of stirrups. Provision can be made for continuity by casting some holes in the columns above the floor at the proper points, through which the reinforcement for negative bending moments will pass, allowing the ends to extend well out in the adjacent panels. When properly grouted into place and panel cast, this will be as strong as if cast as a monolith with the floor.

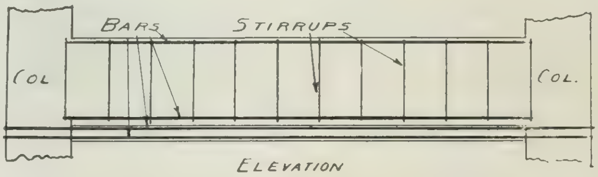
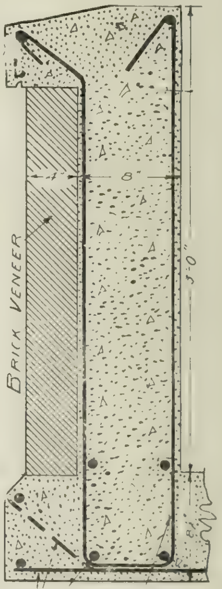


FIG. 2—ELEVATION AND DETAILED SECTION SHOWING SIMPLE NON-CONTINUOUS WALL BEAM

The accompanying sketches are detailed from actual work and show optional methods of constructing a wall beam above the floor slab.

Mr. Wason further states that there is the same strength in the floor whether the wall beam is above or below the slab when the methods shown in the accompanying sketches are used, even though the wall beam may be cast later. It will be noted that Fig. 1 shows a continuous girder action in the wall beams and in Fig. 2 there is no continuous action. The wall beams in Fig. 2 are made somewhat stronger. The continuity shown in Fig. 1 is not always desirable.

The kind of lumber to use for forms and false work depends upon the character of the work, and to a considerable extent on the available supply in the articular locality in which the work is to be erected. For the support of the form work it is the custom to use as cheap a grade of rough, sound lumber as can be purchased.



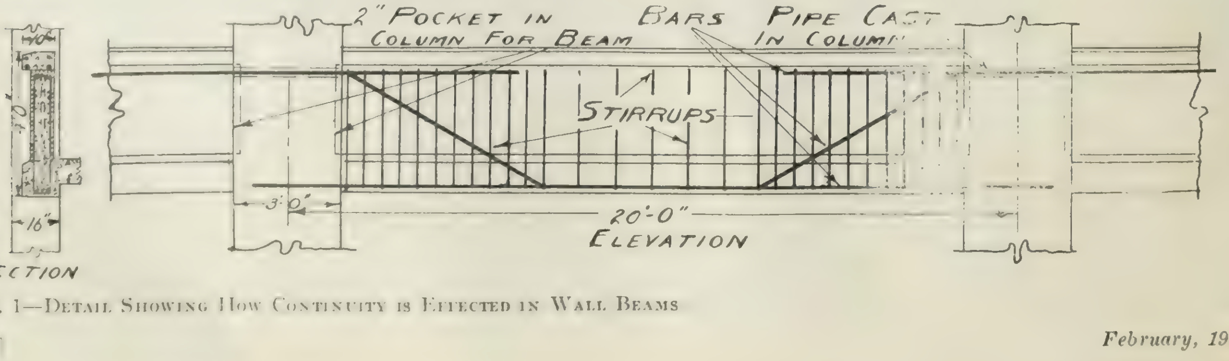


FIG. 1—DETAIL SHOWING HOW CONTINUITY IS EFFECTED IN WALL BEAMS

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Symposium on the Protection of Concrete Against Alkali

A Rich Mixture

Discussed By L. A. Waterbury,[1] R. A. Hart,[2] James Wm. Martin[3] and F. C. Magruder[4]

"Will a rich mixture protect concrete permanently when black and white alkali are in the ground? Or when the water flowing in a canal system is rather heavily charged with alkali for about two months during each irrigation season?"

By Mr. Waterbury

Ordinarily the use of a rich mixture, the aggregate being carefully selected to secure maximum density, will prevent disintegration of concrete by alkalies. The term alkali includes so many compounds, any or all of which may or may not be present, that it is unsafe to use a single example as a guide for other locations. In most instances the destruction of concrete by alkali appears to be due to physical causes, viz., crystallization of salts present in the water. A few cases have been reported in which softening of the concrete has occurred below the water line, which would indicate chemical action as the source of trouble. A study of available data indicates that for the latter cases, magnesium sulphate is probably the principal injurious ingredient. Black alkali (principally sodium carbonate) is probably the least troublesome ingredient of water as regards its effect upon concrete. For freshly placed concrete, the sodium carbonate would probably react with the gypsum used as a regulator for the cement, and so would reduce the time of setting, but this would not be likely to be sufficient to be troublesome.

From discussions which have appeared, those who are not familiar with western conditions might imagine that destruction of concrete by alkali was prevalent throughout the West. The writer has lived in Arizona for seven years and has been on the watch for signs of such disintegration, but not many instances have come to his notice. Most of the instances which have been observed were insignificant, and were not sufficient cause for anxiety concerning the safety of the structures concerned. A great deal of concrete has been used where alkali abounds and has given good service. It is rather the exceptional case in which failure has occurred. Ordinarily, an impervious concrete will prove satisfactory. As a precaution it would be desirable to obtain a chemical analysis of the ground water and of the water in the canal system. If considerable amounts of magnesium sulphate are present chemical disintegration may be expected, and will probably occur below the water line. In this case particular care should be taken to secure impervious concrete below the water line. If the analysis indicates little or no magnesium sulphate, the principal source of trouble will probably be due to crystallization of the salts, and will probably be above the water line. The principal trouble may occur at the latter place, even though chemical disintegration is also present. For prevention of physical disintegration, an impervious concrete is necessary, as much or more care being required above as below the water line. Anything which will reduce the percolation of the water into or through the concrete will be beneficial, and so a dense concrete is the first essential. For important structures additional waterproofing is desirable. Often the soil water will be more strongly charged with alkalies than the water in a conduit, and for such cases particular care should be paid to waterproofing on the outside of pipes.

By Mr. Hart

In my experience, the only possible way of protecting concrete from the harmful effects of alkali is to render the entire mass uniformly impervious to water. I had occasion to determine the feasibility of so protecting concrete and desire to submit the following table showing the tensile strength of 1:2 sand briquettes after having been stored in the solutions indicated for the stated lengths of time:

Table I

Solution	Percentage	Ordinary Briquettes Stored 27 das.	Waterproofed Briquettes Stored 89 das.
NaCl	0.1	372	317
NaCl	1.0	393	389
NaCl	5.0	350	381
NaCl	10.0	491	325
Na_2CO_3	0.1	474	380
Na_2CO_3	1.0	429	371
Na_2CO_3	5.0	423	348
Na_2CO_3	10.0	373	376
Na_2SO_4	0.1	441	409
Na_2SO_4	1.0	380	338
Na_2SO_4	5.0	206	378
Na_2SO_4	10.0	58	357
H_2O	100.0	448	414

These results represent a mean of five experiments. They show that the sulphate is the harmful salt; that the ordinary cement briquette is rapidly destroyed by the stronger solutions; and that there was very little weakening in the case of the waterproofed briquettes even after a much longer period.

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[1] Prof. of Civ. Engrg., Univ. of Arizona, Tucson

[2] Supervising Drainage Engr., U. S. Dept. of Agri., Salt Lake City

[3] Contr. (Martin & Gillis), Phoenix, Ariz.

[4] Project Mgr., U. S. Reclamation Service, Newell, S. D.

In regard to the effect of enriching the mixture as a protection against deterioration by black and white alkalies, I desire to say that black alkali is not especially harmful to concrete except that its presence in the water hastens both the initial and the final set. It is possible to secure an initial set in 6 min. and a final set in less than 1½ hrs. Neither is sodium chloride, classed as a white alkali, harmful; in fact, it actually strengthens concrete to store it in strong brine. Enriching the mixture, however, only serves to prevent injury to the extent that it renders the concrete less pervious. The action of the salts is on the bond between the cement and the sand, so however rich the mixture may be, deterioration will eventually take place unless the mass is rendered impervious to water. It seems that the instant sand is introduced as a component part of the mass difficulty may be expected.

TABLE II

Solution	Percentage	Neat Cement Briquettes Stored for 89 das.
NaCl	0.1	841
NaCl	1.0	861
NaCl	5.0	910
NaCl	10.0	944
Na_2CO_3	0.1	738
Na_2CO_3	1.0	738
Na_2CO_3	5.0	799
Na_2CO_3	10.0	848
Na_2SO_4	0.1	915
Na_2SO_4	1.0	911
Na_2SO_4	5.0	1,037
Na_2SO_4	10.0	1,139
H_2O	100.0	838

In Table II is shown the tensile strength of neat cement briquettes after having been stored for the stated time in the solutions indicated. It will be seen that the cement showed greater strength in almost every instance when stored in alkaline solutions than when stored in water and that generally the strength of the briquettes increased with the alkalinity of the solutions.

This is especially marked in the case of sodium sulphate and particular attention is drawn to the tensile strength of the neat cement briquettes stored in a 10% solution of sodium sulphate for 89 das. as compared with that of the 1:2 sand briquette stored in the same solution for only 27 das. It seems reasonable, therefore, to draw the conclusion that the action is on the bond rather than upon the cement itself and that the prevention of injury by enriching the mixture is only a relative term and that the possibility of deterioration is immediately present whenever any sand is introduced into the mixture.

Speaking from the practical standpoint, the 1:2 mixture would be considered rich and yet the strength of such a mixture was reduced to almost nothing within less than one month's time when the briquette was stored in a strong solution of sodium sulphate. The best that may be stated is that the richer mixtures would be less liable to injury and that the time required for ultimate failure would probably be somewhat less.

BY MR. MARTIN

I believe that a rich mixture will protect concrete permanently when black and white alkalies are in the ground, or when the water flowing in a canal system is rather heavily charged with alkali for about two months during each irrigation season.

I recall hearing of a theory some time ago in which it was stated that the concrete disintegration was caused by absorption of the alkali in solution and subsequent crystallization of the alkali. This appears reasonable to me, or, at least, a theory worthy of careful consideration. As I have had excellent success with concrete in alkali ground and water by using a rich mixture and care in the selection of the sand and gravel or broken stone, I have considerable confidence in its use.

BY MR. MAGRUDER

During the fall of 1912 and spring of 1913 we carried on several experiments on this project to determine the effect of alkali action on concrete. We made a number of test pieces, being 6-in. cubes. In these brands of Portland cement, sand-test pieces we used various standard cement, and cement mixed with McCormick's waterproofing compound,[5] and in one set of test pieces we used Iola Portland cement[6] mixed with 10% mineral oil. We used various mixtures of Portland cement, sand and gravel, varying from a 1:2:4 mixture to a 1:9 mixture of pit-run material; also one set of samples consisting of 1 part Portland cement and 2 parts washed sand. The samples were placed in a concentrated solution of alkali water and remained out of doors for the entire winter. All of the samples were cured for 30 das. before being placed in the alkali water. Those samples which were made of the leaner mixtures showed signs of disintegration first and were completely disintegrated within about 45 das. The same effect was had upon the alkali-proof cement as was had upon the standard Iola Portland cement. The only sample that stood throughout the test was a rich mixture of 1 part Portland cement and 2 parts of clean, washed sand, containing 10½ lbs. per bbl. of McCormick's waterproofing compound. What we gained from this set of tests was that the richer and denser the mixture, or the more impervious to water the concrete could be made, the longer it would withstand the action of alkali, and there is no doubt in my mind that if the concrete could be made waterproof it would permanently withstand the action of black or of white alkali.

I have had occasion to observe several concrete structures that were being disintegrated by alkali action, and in practically all of these structures the water was leaching through the concrete walls and evaporating on the surface. Also in one instance there was a concrete culvert with alkali water standing about 1′ deep in the culvert. The floor of the culvert was absolutely sound but for about 2″ vertically on the side walls at the water line, where evaporation was taking place, there was very rapid disintegration of the concrete walls, indicating that if there is no evaporation in connection with alkali water there is very little trouble to be feared from the action of alkali on concrete.

Use of Linseed Oil

DISCUSSED BY L. A. WATERBURY[1]
AND R. A. HART[2]

"Will painting with linseed oil protect concrete from destruction by alkali?"

BY MR. WATERBURY

The writer hesitates to give any positive answer to the above question,

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[5] McCormick Waterproofing Portland Cement Co., St. Louis

[6] Iola Portland Cement Co., Iola, Kans.

[1] Prof. of Civ. Engrg., Univ. of Arizona, Tucson

[2] Supervising Drainage Engr., U. S. Dept. of Agri., Salt Lake City

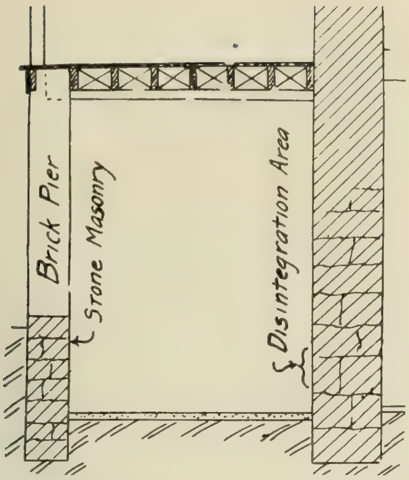


Fig. 1—Vertical Section of First-Story Wall and Veranda, University Hall, Univ. of Arizona, Tucson

but is inclined to believe that under some conditions painting will prove beneficial, while under other circumstances it will probably be of little benefit. A consideration of the action of alkali may be of assistance in predicting the probable effect of alkali, under given conditions, and the probable effect of painting the masonry surfaces.

One very good example of the action of alkali, which has come to the writer's attention, is the foundation of University Hall, of the Univ. of Arizona, located at Tucson. The building is 200′ x 150′ in plan, is two stories in height, and has a two-story veranda around the entire building. The walls of the first story are of gray stone (a volcanic tuff), and the second story walls are of red brick. The building was constructed in 1890, the foundation probably having been laid in 1889. The floor of the first story is approxamately 4′ below the surface of the ground at the north end and 6″ below the surface at the south end. A section of the lower part of the veranda, together with the wall of the building and the retaining wall at the outside edge of of the veranda, is shown in Fig. 1. The retaining wall is built of the same kind of stone as that used for the wall of the building. Brick piers resting upon the retaining wall carry the floor of the veranda for the second story.

Upon the wall of the building a deposit of alkali is forming, which is disintegrating the stone and the mortar. This action is occurring around the entire building, the area of disintegration being close to the floor line at some places, and as high as 3′ above the floor at other place. The principal area of attack is at least 1′ above the floor. Below and above this zone there is no appreciable disintegration. This zone of action is shown in Fig. 2, appearing as a white area due to the exposed crystallized salts. Upon the floor may be seen some of the spalls which have been thrown off from the wall. In Fig. 3 an area of wall is shown where the entire surface of the stone has been loosened and is about ready to fall. This loose scale was taken off and another photograph of the same area was taken, with the camera in the same position for both views. The second view is shown in Fig. 4, in which it will be seen that a heavy, white, crystalline deposit has been exposed. Over the zone of disintegration the mortar in the joints has crumbled into sand and dust, near the surface of the masonry. The depth of disintegration of the mortar is much greater than that of the stone, as may be seen in Fig. 2.

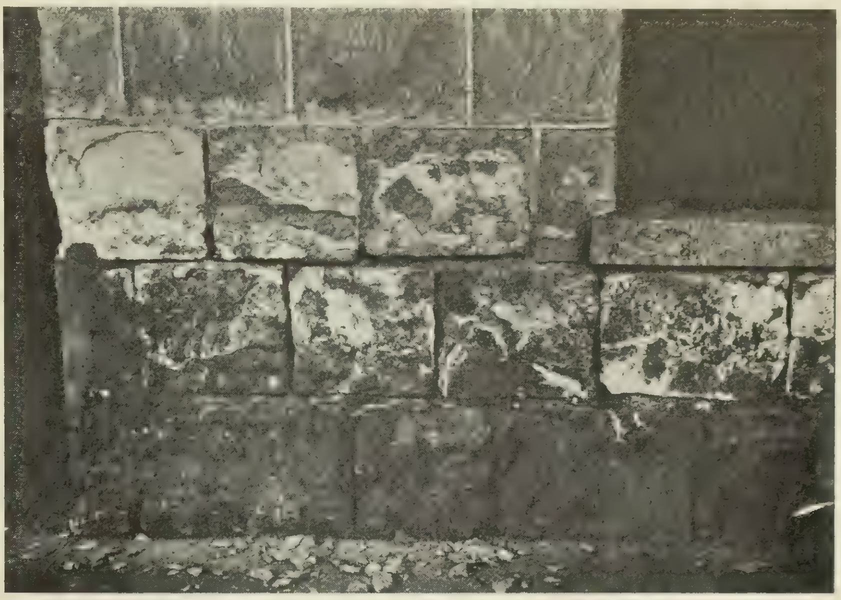
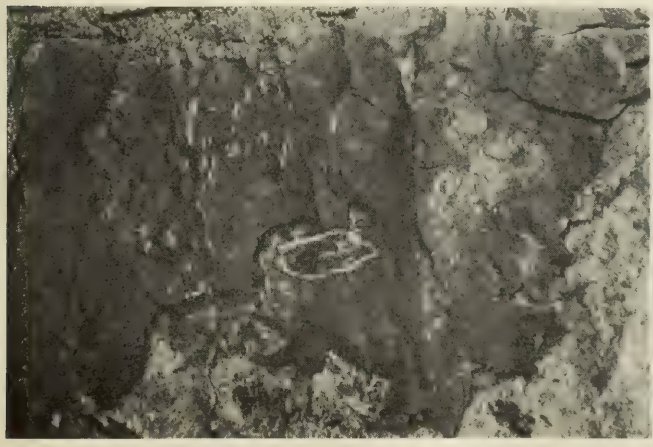


Fig. 2—View Showing Zone of Disintegration

Upon the inside face of the retaining wall there are a few places where efflorescence occurs, but here the salts have formed a deposit upon the surface of the wall, and neither the stone nor the mortar is appreciably



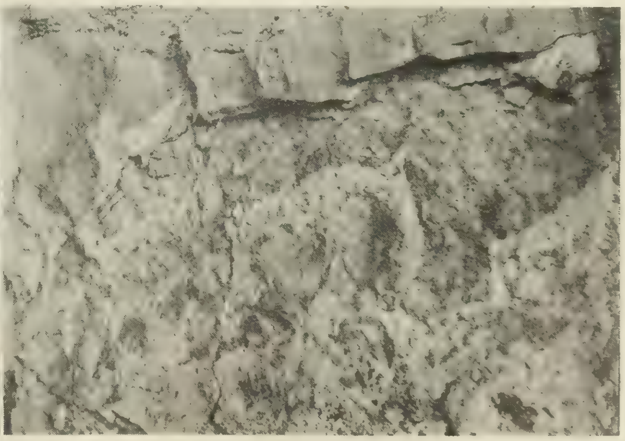


Fig. 3—Surface Layer of Stone Loosened by Alkali

Fig. 4—Crystalline Deposit Exposed by Renewal of Loosened Layers of Stone

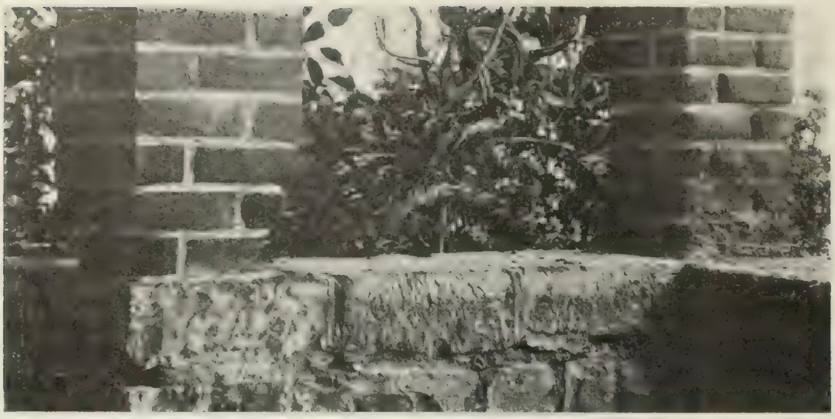


Fig. 5—Brick Piers Disintegrated by Alkali

disintegrated. However, upon the wall rest the brick piers which support the veranda above, and the lower portion of nearly every one of these piers has been attacked, and the majority of the piers have already been repaired with Portland cement mortar. Two piers which have not been repaired are shown in Fig. 5.

Upon the inside of the building, the alkali has caused disintegration of the plaster and injury to the wall decoration. The original zone of trouble with the plaster was at or a little above the zone of disintegration upon the outside. For a part of the building the plaster on the lower portion of the wall was removed, and replaced to a height of approximately 4′, thus forming a winscot, the surface of which was painted. This has changed the location of the zone of trouble, moving it up to a point near the top of the wainscot. In some places the disintegration is occurring above the wainscot, while in other places crystallization is occurring on the wainscot, forming a layer which loosens the paint.

All of the crystalline deposits formed, in the various parts of the structure, appear from their taste to be composed largely of common salt.

Consider now the action which is responsible for the various phenomena mentioned. Why is it that in the case of the retaining wall a deposit is formed without disintegration, while in the case of the building wall the surface is being destroyed? Why does the action occur at a particular zone, and why did painting the inside surface of the wall change the location of the zone of attack? Apparently the principal action is merely the crystallization of salts, from soil water, together with the expansion, similar to the effect of freezing, which is produced during the crystallization. Destruction of masonry from such action will occur when this crystallization takes place in the interstices of the masonry, but close enough to the surface so that the overlying masonry is too weak to resist the stress due to the expansion. In the case of a wall of a building the bottom of the wall is likely to rest upon soil which is moist, so that the soil water is drawn up into the wall by capillarity. At the zone which forms the limit of capillarity extreme concentration of the soluble salts will occur, and only at this place will crystallization take place. If destruction from alkali were the result of chemical action it is probable that all of the foundation impregnated with soil water would be seriously damaged. In the example cited no destruction of the stone below the zone of crystallization was noted and it is the writer's belief that in the majority of cases the destruction by alkali is to be attributed to physical rather than to chemical phenomena. In a vertical wall the evaporation ordinarily occurs at the side walls and if the soil water is drawn upward the surface forming the limit of percolation will be convex upward. There will be a certain area at which the limit of percolation lies close to but beneath the surface, and here the crystallization will split off the overlying layer. In the case of the retaining wall mentioned the limit of capillarity is in the brick piers, above the wall; thus the entire wall is saturated, only a small amount of salt is deposited, and this deposit is entirely upon the surface, causing no disintegration.

If the action of alkali has been correctly explained, the obvious methods of prevention of disintegration would seem to be (1) by preventing water charged with soluble salts from entering the masonry; (2) by preventing evaporation of water near the surface of the masonry; or (3) by forcing evaporation to occur entirely upon the surface. For concrete structures evidently the use of an impervious mixture is always desirable. In the wall of a building the use of a waterproof membrane below the limit of capillarity will prevent the wall from acting as a wick. The use of linseed oil or of any similar coating is an application of the second method of prevention mentioned. In any case it should retard the evaporation and may prove sufficiently effective for a particular case. In general it would probably not entirely prevent the crystallization.

By Mr. Hart

In my opinion, nothing in the way of coating concrete with oil or any other waterproofing material will suffice to prevent destruction of the concrete by the activities of the alkaline sulphates. Concrete may be coated with tar or painted with tar products, but the smallest scratch will allow the saline water to come in contact with the concrete and capillary attraction will do the rest. The ultimate result would be that the structure would become a mass of disintegrated material, held together (perhaps) by a thin shell of coated surface concrete. It is characteristic of concrete structures that have failed that the internal mass is disintegrated but that an outer shell remains fairly intact. This is due to the fact that the mixture is richer at the surface, due to the manipulation during construction.

(Contributed)

The painting of concrete with linseed oil would be entirely ineffective, unless the concrete had been aged for some time before the oil was applied. If this were not done, the lime freed during the process of setting in connection with moisture would rapidly saponify the oil and lessen any beneficial results that might be produced by painting with it. However, in the case of alkali disintegration the painting would have to be done immediately in order that the alkali might not come in contact with the green concrete. The injury done to concrete by alkali occurs very shortly after the concrete has been placed. If the latter could be aged before being subjected to the alkali, all injurious effects would be very markedly reduced.

It should be borne in mind that the denser the concrete the less effect alkali has upon it, and consequently painting with cement grout would in a number of cases prove beneficial. Moreover, the painting of green concrete with any saponifiable oil is a questionable procedure on account of saponification, and for this reason we find most concrete paints contain a minimum amount of linseed oil, but very slowly saponifiable hard resins. contain as much as possible of the In case a linseed oil paint is used, you will find that the manufacturer of the paint recommends the use of such primers as solutions of silicate of soda and zinc sulphate, either of which will take care of any free lime produced.

Expansion Joints Over Beams and Girders □ □ □

Discussed By John T. Simpson[1] and Albert M. Wolf[2]

"One of the disturbing features in the construction of a steel frame building with reinforced concrete arches is the fact that cracks appear on the surface of cement, tile or terrazzo floor over the beams and girders, after a week or 10 das. have passed.

1. "Would the arch, if carried the full depth over the beams and girders, the reinforcement being set up above the top flange of the beams or girders to insure the proper distribution of reinforcement, and the encasing of the beams and girders being separate from the arch, show any evidence of shrinkage cracks?

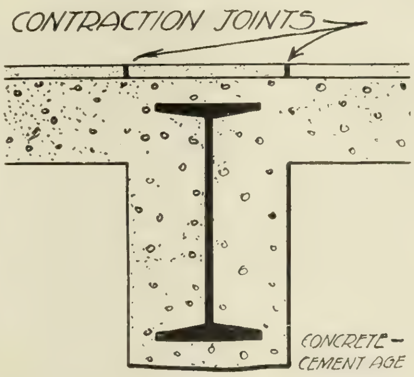
2. "If so, where would they be likely to occur?

3. "Would it be well to make an expansion joint, say about every 15′, or on the line of columns?"

By Mr. Simpson

Replying to the inquiry regarding the cracking of cement surface, tile or terrazzo floors over beams and girders, a week or ten das. after they have been installed, would say that this particular feature in fireproof construction has been one of the most annoying in the building trade, and the writer has personally tried many different ways to eliminate this fault.

It is almost impossible to overcome the expansion of such construction due to the relatively large size of the beams as compared with the thin section of the surface to reinforce the two members sufficiently to prevent expansion joints. Therefore, after a number of experiments in the various methods of reinforcement, including the carrying of full-size slab over top of beams, the writer found that the most satisfactory way to deal with this problem was to make an expansion joint through the top filling of cement, terrazzo or tile along the line directly over the outside edge of the outside concrete surface of the beam, allowing the expansion to come out at this point. This has the effect of marking off a narrow panel directly over the beam the same width as the beam, as shown in the accompanying sketch, and giving the top surface an opportunity of expanding at the joint of the beam and the slab.



Sketch Showing Location of Expansion Joints Over Face of Beams

On several buildings on which the writer has followed this method, no expansion joints appear except along the lines established for them, providing the expansion over the slab as having the effect of filling the cracks between slab and beam, and the only method the writer has yet found that guarantees the elimination of these cracks is the one above described.

By Mr. Wolf

In the writer's opinion the cracks which appear over beams and girders in steel frame buildings with reinforced floor slabs are not so much due to shrinkage as to the difference in the general action of steel framing and monolithic concrete construction; steel framing acts, in practically all cases, as a series of simple I-beams, while concrete construction tends to act as a more or less continuous structure. This combination, it can readily be seen, is not an ideal one and is therefore almost sure to develop faults.

Then again in steel frames a limiting deflection of $\frac{1}{360}$ of the span is allowable and practically all of the longer members of a steel frame floor will at their rated loadings have deflections very closely approximating this figure. This is due to the fact that nearly all designers design steel beams carrying concrete floors for strength instead of deflection or in accordance with the current practice for steel frame buildings with tile floor arches. Now if a concrete member encased in concrete deflects $\frac{1}{360}$ of the span, the concrete will be seriously cracked. To prevent this trouble, the steel members should be designed for a maximum deflection of, say $\frac{1}{600}$ of the span.

Having designed the supporting frame for limited deflection, attention should be paid to reinforcement of slabs over the supporting beams and girders to insure continuous action. This means that sufficient reinforcement should be provided over support to care for the negative moment developed and that something more than just an inch or two of concrete over the top flanges of beams, for such a sudden change in depth of slab increases the bond stresses very suddenly which tends to develop cracks in addition to those likely to be caused by shrinkage which displays its effects at points of sudden change in depth of concrete. If the slab is carried entirely above the flanges of beams, the best results should be obtained, this, of course, increasing the depth of the floor construction and necessitating higher stories for the same effective height.

Encasing the beams and girders separate from the arch or slab would not be economical from the contractor's standpoint, and not likely to give any better satisfaction. The presence of numerous expansion joints would be just as undesirable. even if not quite so unsightly as ragged cracks, and cannot be looked upon as a solution of the problem.

The combination of steel framing with concrete floors is by no means so economical as a construction built entirely of reinforced concrete and if the former type is designed to avoid the difficulties mentioned the extra cost will throw the balance decidedly in favor of reinforced concrete especially of carefully designed girderless floors or flat slabs.

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[1] Arch. and Engr., Newark, N. J.

[2] Prin. Asst. Engr., Condron Co., Structural Engrs. Chicago

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Concrete in Cold Weather

A Letter from Leonard C. Wason[1]

Long experience can best overcome the obstacles attached to construction work in winter. In laying brick there is danger of the mortar freezing, and in concrete work, danger of the concrete freezing. But while brick walls will generally stand by their own weight, even if the mortar is destroyed by frost, concrete subjected to frost is extremely treacherous. If it is frozen it will be as hard as properly set concrete, but if the forms are removed the work will collapse as soon as a thaw comes. It is true that frozen concrete will, if the forms are kept in place, set properly when the thaw comes, and experiments have shown that the strength may be slightly increased in this way. But only an expert can distinguish between the appearance of frozen concrete and concrete which has set properly.

Our location in New England has made it necessary for us to do a great deal of difficult winter work. From our experience with it, we do not hesitate to recommend the use of reinforced concrete for erection at any time in the year. Each winter we have carried through three or four good sized jobs, and can confidently assert that, in strength and excellence of workmanship, they are fully equal to any summer concrete work. We are willing to undertake and to guarantee concrete work under the most adverse cold weather conditions.

PRECAUTION TO BE TAKEN

From the boiler a steam pipe is taken to the sand pile and another one to the stone pile. A canvas should be thrown over the top of the stone pile to retain the heat and keep out storms. On jobs where sand and stone are received on railroad cars a steam pipe laid parallel with the tracks is provided with at frequent intervals, from which hose may be taken directly into the car. This insures that all sand and stone are warm when placed in the mixer. Similarly, steam turned into the water barrel heats the water used in the mixing. The cement is not heated, for this would too greatly accelerate its setting. Salt is frequently mixed with the concrete—from ½ lb. to 2 lbs. to each bag of cement—as a precaution against sudden unexpected drops in temperature. This lowers the freezing point of the water in the concrete, and although it slightly retards the set of the cement, it does not seriously impair its strength.

Before pouring concrete, all forms are swept clean of snow, and ice is removed with a steam jet. The building as it goes up is enclosed with canvas, floor by floor, until the concrete has fully hardened. Salamanders burning coke are placed underneath all freshly poured concrete and kept burning night and day until the hardening is complete. In this way the inside of the building is kept about 30° F. above that of the air outside. Care is necessary in using salamanders because of the risk of formwork fire—an accident which we have been fortunate in avoiding. The tops of freshly poured concrete floors, which cannot well be enclosed in canvas, are covered with paper and about a foot of hay or straw, the latter sometimes sprinkled with salt. Several other methods are used, as circumstances dictate. Little care need be used to prevent *mass* concrete from freezing, as the frost will usually strike to a depth of about 1″ only.

It is very common in winter, because of the danger of freezing, to put the finish on as a separate operation after the building is all enclosed, and not as an integral part of the construction. When it is so put on, it must be kept from frost for the first 48 hrs. at least.

The expense of protection against the weather is not very great—perhaps from 6% to 10% more than the cost of the concreting in warm weather. A part of this extra expense is due to the heating operations, a part to the decreased efficiency of workmen numbed by cold, and a smaller part to the comparatively slow progress of work due to allowing a longer period for the concrete to harden. In spite of this, we have found each year several owners who have considered it worth while to pay this extra cost on the score of certain and early delivery of completed buildings the first of the new year.

Occasionally it is necessary to make some provision for the protection of the men. Shelters or wind-shields are built in front of the benches where carpenters are making up forms, as well as around the men at the concrete mixer, whose work does not necessarily keep them warm. Where excavation is going on in the open it pays to have a building with a good fire, where the men can warm themselves when necessary. On a few particularly cold jobs it has proved wise to furnish hot coffee, free, in these shelters.

Among the reinforced concrete buildings which we have erected, wholly or partly in the winter, are automobile and shoe factories, textile and paper mills, warehouses, office buildings, machine shops, garages, dams, filters, etc. Notable among these buildings are the 10-story Larkin warehouse and freight terminal, containing over 14 acres of floor space; the Hood Rubber Co. warehouse, with reinforced concrete girders of 86-ft. span—the largest, with two exceptions, in the world; the storage and nickel-plating buildings of the Pierce-Arrow Motor Car Co., and a building for the Pacific Mills at Lawrence, Mass.

The Use of Grout Filler in Brick Paving

A Letter from F. A. Churchill[1]

In round numbers the output of paving brick in 1912 amounted to 564,000,000. Figures for 1914 are not yet available. The equivalent in sq. yds. of 554,000,000 brick is 13,850,000. As 1 bbl. of cement, mixed with an equal volume of sand, will ordinarily fill the joints of 35 sq. yds. of brick pavement, it would require 395,715 bbls. of cement to grout 13,850,000 sq. yds. of povement.

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[1] Pres. Aberthaw Construction Co., Boston

[1] The Dunn Wire-Cut-Lug Brick Co., Conneaut, Ohio

As the standard brick pavement is laid on a concrete foundation varying from 4″ to 6″ in depth, and as the concrete is usually a 1:3:6 mixture, 1 bbl. of cement lays approximately the foundation for 6 sq. yds. of pavement. Foundation for 13,850,000 sq. yds. of pavement would take, therefore, 2,308,333 bbls. of cement, which, added to the 395,715 bbls. required for filler, would aggregate 2,704,048 bbls. of cement for the year 1913, if all brick pavement had been laid with a concrete foundation and with cement-grout filler.

Of course these figures represent the extreme possibilities of the year, but they serve to show that the field for exploitation of cement for brick pavements is worth cultivating.

The Natl. Paving Brick Mfrs. Assn., and the Am. Soc. of Municipal Improvement are agreed that cement-grout filler, a 1:1 mixture, is the only filler that ought to be used in a brick pavement. Sand fillers and soft fillers of the asphaltic type are unsatisfactory on account of softening and working out from the joints, leaving the edges of the brick unprotected so that they wear off from abrasion, thereby causing a rough and noisy pavement and leaving the joints as open receptacles for street filth, dust, etc.

Even in transverse expansion joints, soft fillers have proven so destructive of pavements that the transverse joint has been condemned by every competent authority, and by state highway departments of such states as N. Y., Ohio and others.

Experience has demonstrated the validity of the theory that the more nearly monolothic a brick pavement is the longer is its natural term of serviceable life. A monolithic structure is possible with cement-grout filler only. Brick should have a rough contact surface for bonding and square edges which permit of a flush surface joint. If properly grouted, the flush joint cannot chip or wear out. It protects the edges of the brick and is protected by the square edges of the brick, so that brick and joint wear evenly and smoothly under traffic abrasion.

Wherever we are able to control the situation, none of our brick is allowed to be laid without a cement-grout filler, and the exceptions have been so rare as to be negligible.

If the concrete surface has been bady hair-cracked, from heat, the defect can easily be remedied by rubbing with an ordinary carborundum block, and applying a thin cement or mortar grout, well rubbed in.

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa. Convention, Auditorium Hotel, Chicago, Feb. 9-12, 1915.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago. Convention, Chicago, Feb. 15 and 16.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager. Show, Chicago Coliseum, Feb. 10-17, 1915.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

Mid-West Cement Show, Omaha, Neb., Mar. 2-6, 1915.

National Conference on Concrete Road Building, J. B. Beck, Sec., 208 S. LaSalle St., Chicago.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention, Omaha, Mar. 2-6, in connection with Mid-West Cement Show.

American Concrete Institute

The eleventh annual convention of the American Concrete Institute will be held at the Auditorium Hotel, Chicago, Feb. 9-12, 1915. The Convention will mark the completion of the 10th year of the existence of the Institute. The sessions will be at 10 a. m., 3 p. m., and 8 p. m.

The tentative program, announced as follows, suggests the probability of interesting contributions to the general knowledge of concrete:

CONCRETE ROADS AND BRIDGES

Tuesday, Feb. 9—Opening Address of Welcome. Review of Present Practice in Concrete Road Construction, by Percy H. Wilson, Secy. Assn. of Am. Portland Cement Mfrs., Philadelphia. The Experimental Concrete Road in Philadelphia, by William H. Connell, Chf. Bur. of Highways, Philadelphia. Reinforcing Narrow Concrete Roads, by John Mueller, Civil Engineer, New Castle, Ind. Report of Committee on Concrete Roads, A. N. Johnson, Chairman.

3:00 p. m.—Comparative Cost of Concrete Roads, by Percy H. Wilson, Secy. Assn. of Am. Portland Cement Mfrs., Philadelphia. Cost of Construction and Maintenance of Concrete Roads, by H. J. Kuelling, County Highway Commissioner, Milwaukee. The Construction of Integral Curbs, by Charles E. Russell, City Engineer, Highland Park, Ill. Organization and Methods of Constructing Concrete Roads, by William Acheson, Division Engineer, New York State Highway Commission, Buffalo.

8:00 p. m.—Test of a Reinforced Concrete Slab Bridge, by E. B. McCormick, Mechanical Engineer, Office of Pub. Roads, Washington, D. C. Standard Deigns for Concrete Highway Bridges and Culverts, by C. B. McCullough, Designing Engr., Iowa State Highway Commission, Ames, Ia. Report of Committee on Standard Specifications for Concrete Highway Bridges and Culverts, William Whited, Chairman.

CONCRETE AND REINFORCED CONCRETE TESTS AND DESIGN

Wednesday, 10:00 a. m.—Report of Committee on Concrete and Reinforced Concrete by A. E. Lindau. Report of Committee on Nomenclature, by F. C. Wight, Chairman. Report of Committee on Insurance, by J. P. H. Perry, Chairman. The Design of Wall Columns and Wall Beams, by Sanford E. Thompson, Consulting Engr., Newton Highlands, Mass. A New-Old Theory for Reinforcing Concrete in Bending, by L. J. Mensch, Contracting Engr., Chicago. The ballot box closes at noon.

3:00 p.m.—Reinforced Concrete Stands, Stadiums and Bowls, Charles W. Leavitt, Jr., Civil and Landscape Engr., N. Y. C. The Design of Concrete Bins for the Storage of Cement, by Leonard Wesson, Asst. to President, Universal Portland Cement Co., Chicago. Tests on Egg-Shape and Circular Reinforced Concrete Sewer Pipe, Albert Goldbeck, Engr. of Tests, Bur. of Surveys, Philadelphia.

8:00 p. m.—Annual Address of President Richard L. Humphrey, Philadelphia. A Critical Review of Current Practice in Reinforced Concrete as Embodied in Building Regulations and the Joint Committee Report, by Edward Godfrey, Consulting Engr., Pittsburgh. Basis of Current Practice in Design of Reinforced Concrete Structures, by C. A. P. Turner, Consulting Engr., Minneapolis.

CONCRETE IN ART AND ARCHITECTURE

Thursday, 9:00 a. m.—Business Session. Annual Report of Board of Direction. Report of Tellers.

10:00 a. m.—Report of Committee on Edison Fire, by Case Gilbert, Chairman. Concrete; A Medium of Esthetic Expression, by Irving K. Pond, Architect, Chicago. Report of Committee on Cement Products, by C. K. P. Arp, Chairman. Cement Tile, by J. S. Freund, General Manager, American Cement Tile Mfg. Co., Pittsburgh.

3:00 p. m.—The Fireproof Home, by R. P. Stoddard, Executive Secretary, Society Advocating Fire Elimination, Cleveland. Report of Committee on Treatment of Concrete Surfaces, by L. C. Wason, Chairman. A New and Simple Method for Securing Dustless Concrete Floors, by P. M. Bruner, P. M. Bruner Granitoid Co., St. Louis. Topical Discussion on the Dusting of Concrete Floors.

8:00 p. m.—Annual Banquet in celebration of 10th anniversary.

PLANT MANAGEMENT AND COST

Friday, 10:00 a.m.—Contractor's Equipment, Austin-Nichols Warehouse, by

T. A. Smith, General Supt., Turner Construction Co., N. Y. C. Mechanical Plant for Handling Concrete, by Wm. P. Anderson, President, Ferro-Concrete Construction Co., Cincinnati. The Strength of Concrete Forms, by Harrison B. Taft, Contracting Engineer, Seattle, Wn. Concrete Forms for the Catskill Aqueduct, by Alfred D. Flinn, Deputy Chief Engr., N. Y. Bd. of Water Supply, N. Y. C.

3:00 p. m.—Design and Construction of the Massachusetts Institute of Technology Buildings, Sanford E. Thompson, Consulting Engr., Newton Highlands, Mass. Report of Committee on Methods of Tests and Standard Specifications for Concrete Materials, Sanford E. Thompson, Chairman. Placing Concrete with High Pressure Steam, by Harold P. Brown. N. Y. C. Some Further Properties of Portland Cement Having a High Percentage of Magnesia, by P. H. Bates, Chemist, Bur. of Standards, Pittsburgh.

Concrete Roads—Facts and Opinions from the American Assn.

Supplemental to the general report of the convention of the American Roadbuilders Assn. convention in Chicago, published in the Jan., 1915, issue, same excerpts from papers and discussions at that meeting are now presented.

In view of the fact that elsewhere in this issue there is a paper by H. J. Kuelling,[1] prepared especially for this magazine, and going into considerable detail on the concrete road work in Milwaukee Co. in 1914, it is superfluous to publish all of the brief paper presented by Mr. Kuelling at Chicago. Following, however, are some excerpts in which are some views as to methods differing considerably from what has been regarded as standard practice. Mr. Kuelling said:

Roadbed.—As in all forms of road construction, the roadbed for a concrete road is almost as important as the wearing surface itself. However, because of the rigid nature of the pavement, I believe that the roadbed can be of poorer quality for this form of road construction than that in any other form that I know of. This does not mean that I recommend the neglecting of proper preparation of the roadbed; but as engineers know, in preparing a road in very dry weather, springy or spongy places are sometimes overlooked and in the cases of non-rigid roads these places will show up at some future date, whereas with a concrete road I believe that the slab often bridges these places and no serious results come about excepting a possible cracking of the road. I think a little too much attention has, perhaps, been paid to thorough rolling of the sub-grade rather than to the thorough destruction of the old road surface in order to have a sub-grade of uniform density under the new road. In my own work, we did practically no rolling other than that accomplished by traction engines drawing the graders; or, in a few cases, by tractors hauling material.

Pit-Run Gravel.—In no case would I permit the use of pit-run material in the concrete road.

Proportions.—I believe that too often the proportions are specified more or less blindly. I believe that they should depend absolutely upon the quality of the material that is obtainable. This necessitates a careful study of the voids and the make-up of the gravel or stone that might be used. I believe that uniformity of mixing is as important almost as the amount of cement demanded. I believe that the proportions should be those that will give the greatest density and most homogeneous concrete that can be obtained with the sand and stone obtainable. If the addition of hydrated lime or some other inactive material will tend to assist in obtaining these results without lowering the abrasive value of the concrete, I believe it should be included in the proportions. I believe there is a wide field open for careful experiments along this line. Personally, I hope to make some abrasive tests in the near future on different mixes containing hydrated lime. At the present time I am using a mix of 1:2:3½, but I would not for a moment say this is the proper mix for all parts of the country.

Reinforcement.—I believe it is in exceptional cases only that reinforcement is necessary in a country road, these cases being only when springy spots are encountered or possibly where sufficient drainage is impossible due to the swampy nature of the territory.

Placing.—For road work proper, I prefer a spout to a boom. The main reason for this is that the material is deposited in smaller quantities, with, therefore, less tendency toward separation of the aggregate and mortar. Very commonly the boom bucket leaks and unless careful watch is maintained there is a pile of mortar left at each moving of the machine. Further, the boom is additional weight to be carried around and is often the cause of delaying the work.

Joints.—The question of joints is, I believe, the most unsettled one in connection with concrete roads. We have increased our joint spacings from 25′ to 35′ and from 35′ to 50′ and at the present time I see no reason for shortening the spacing. I doubt very seriously the necessity for steel protecting plates, for no matter how carefully they are placed there is a tendency to chip, thus demanding an almost immediate tarring of the joints. I believe the joints of the future will be merely felt or paper with a slight rounding of the joint, with an edging tool, which will be filled in by the pounding down of the felt which has been permitted to stick up above the surface. I believe that the ability to get concrete that is homogeneous and impervious to water will have a marked effect upon the spacing of joints, as water content is more the cause of the movement in concrete than the changes in temperature.

Shoulders.—After trying both gravel and earth shoulders we have practically come to the conclusion that for double track roads, earth shoulders are preferable. We have found that it is not necessary to bevel off the edges of the concrete in order to make the shoulders stay in place and now merely round the edges to about a 1-in. radius.

Following Mr. Kuelling's paper, Frank F. Rogers[2] presented a discussion in which he made a report of a further census of defects in the earlier Wayne Co. (Mich.) roads. The first report[3] was presented at the convention of the American Highway Assn., Detroit, Oct., 1913. Mr. Rogers' discussion follows in part:

Concrete roads are no longer looked upon as an experiment, and deserve serious consideration in determining the type of highway which is to be built whenever a community can afford to expend from $10,000 to $15,000 a mile in road construction.

Concrete roads are growing in popularity in Mich., and the writer believes deservedly so. Up to Dec. 1, 1914, 104 mi. of state reward concrete road had been built in my state in seven counties, although all but 7 mi. are located in the County of Wayne.

The writer is firmly of the opinion, however, that the first few miles, say from two miles to five miles out of each large market town, should be built of a more permanent type of road than is usually chosen. However, such catch phrases as "The best is not too good," and "The most expensive road is the cheapest in the long run," often used by road promoters, must always be taken with the proverbial "grain of salt" for economic reasons which are obvious to the road engineer.

It has been charged by some opponents of the concrete road that it will be short lived and that if it does not break up under traffic, it will crack so badly in a few years by action of the elements that it cannot possibly be a long-lived structure.

The writer became convinced several years ago that a well built concrete road will not wear out under heavy country road traffic in a single generation, but was not so certain that the elements would not get the best of it in a few years, and that it would become so badly broken up that it would have to be rebuilt or rejected entirely.

Accordingly in Sept., 1913, arrangements were made with the Road Commissioners of Wayne Co. for a systematic count of the defects in every slab covering some 30 miles of concrete raod in that county. This was done with a view of keeping it up for a period of several years for the purpose of making a reasonably accurate estimate as to the probable life of such roadways.

The record made at the time of that count was tabulated and presented by the writer in a paper on concrete roads before the American Road Congress held in Detroit, Oct., 1913. A second count was made of the defects, in these slabs one year later, Sept., 1914, and I wish to make a brief mention of the result of this second count at this time.

The accompanying table reproduces the old table to the extent of giving the location of the road; number of 25-ft. sections observed on each road; width and depth of concrete; aggregate and mix used; year built; soil built on; and a traffic record. The defects are classified as longitudinal, transverse, and diagonal cracks and holes. The table shows the number and kind of defect noted in each of the two years; the total number of defective slabs at each count, and the increase in numbers and percentage of increase during the last year.

The oldest road covered by these observations consists of 209 sections of 18-ft. roadway on Woodward ave., built in 1909. Last year, 61.7% of the slabs were defective and this year 72.7%, showing an increase of 11%.

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[1] Highway Commr., Milwaukee Co., Wis.

[2] State Highway Commr., Mich.

[3] CONCRETE-CEMENT AGE, Oct., 1913, issue

This is the oldest road and shows the greatest percentage of defective slabs, but it does not show so great a percentage of increase in defective slabs as do some of the other roads, for six other roads show a greater percentage of deterioration, though none of them had a total of over 49% of defective slabs.

It might be argued that if the defects increase on this Woodward ave. Road at the same ratio for three more years, there will then not be a perfect slab in the entire pavement. This might be true, but careful examination of the present condition of the pavement and the methods of keeping it in repair will readily convince one that, even if every slab were as defective as the worst slab is today, the pavement would still be good for many years.

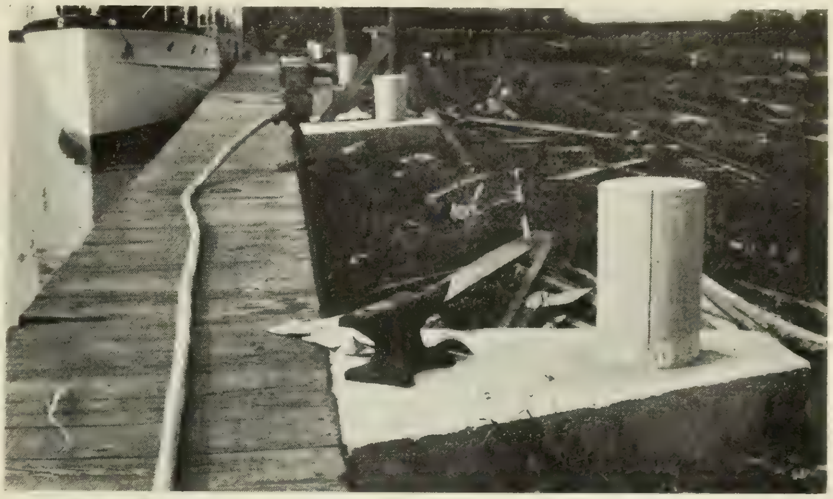
The writer is pretty well convinced that the cracks and other defects noted thus far are not much more serious than the expansion joints, laid transversely every 25′, for every year the transverse joints, cracks and other defects are cleaned, filled with a very heavy grade of refined tar, and sanded. This treatment has so far proven such an excellent preservative of the pavement as a whole that the defects noted may be considered more as marring the appearance of the pavement than as something which will soon cause its destruction.

Time will not permit a more extended study of this table, but the writer is becoming convinced, even at the present ratio of increase in the defects noted, that if the present methods of repairs are maintained, these concrete pavements will last as long as, and possibly longer than most other kinds of high grade pavements, and that they really have proved an economical investment for the county when the first cost, interest on the investment and cost of repairs are all considered.

Concrete Anchor Posts

Among the new things to be seen along the river front in Port Clinton, Ohio, is a concrete post, which will no doubt become very popular after once being introduced in the marine centers.

This post is made solid in a steel or galvanized iron case about 2 ft. high and 1 ft. across the top. The foundation is made of several hundred pounds of concrete and built about 10 ft. from the water's edge, thus giving the laborers a chance to work at the boats alongside of the dock and being out of the way. The steel casing makes it impossible for the rope to wear away the post, as in the case of wood, and there is no deterioration from rotting. The concrete post will cost a little more than the wood in first cost but will be cheaper, as it will require no replacing or upkeep. The Mathews Boat Co. originated the new post and has found it to be very satisfactory.


Concrete Anchor Posts, Port Clinton, Ohio

In pouring slabs the full thickness must be placed in one continuous operation, as work should never be stopped off at horizontal planes. If possible, slab and beam should be made monolithic. After the floor slabs have begun to harden, they should not be walked on or wheeled over for some time after placing, as otherwise their strength is seriously injured. If traffic over them is unavoidable, boards should be provided for the purpose of distributing the weights.

WAYNE COUNTY – CONCRETE ROADS – TABLE 1

NAME OF ROAD	NUMBER OF 25 FT. SECTIONS	WIDTH	DEPTH	AGGREGATE	MIX	YEAR BUILT	SOIL BUILT ON	TRAFFIC COUNT 24 HRS. AVERAGE 1 WEEK	% MOTOR DRIVEN	% HORSE VEHICLES	DEFECTS																
											LONGITUDINAL CRACKS		TRANSVERSE CRACKS		DIAGONAL CRACKS		HOLES		TOTALS		GRAND TOTAL	DEFECTIVE SLABS 1913		DEFECTIVE SLABS 1914		INCREASE DEFECTIVE SLABS 1 YEAR	
											1913	1914	1913	1914	1913	1914	1913	1914	1913	1914	Number	No.	%	No	%	No	%
WOODWARD AVE.	209	18′	6½″	CRUSHED COBBLES SAND	1-2½-5 1-2-3	1909	CLAY LOAM	2160	88.1-	11.9+	80	28	32	18	2	2	46	17	160	65	225	129	61.7	152	72.7	23	11.0
WOODWARD AVE.	252	18′	6½″	CRUSHED COBBLES SAND	1-2½-5 1-2-3	1910	SAND LOAM				29	23	22	5	6	2	18	11	68	48	116	59	23.4	93	36.9	34	13.5
GRATIOT AVE.	326	16′	7″	WASHED PEBBLES SAND	1-1½-3	1911	CLAY LOAM	507	65.8+	34.2-	11	8	10	5	3	7	6	38	30	58	88	28	8.6	71	21.8	43	13.2
GRANDRIVER AVE.	61	18′	6½″	CRUSHED COBBLES SAND	1-2½-5 1-2-3	1909	CLAY LOAM	1064	56.5+	43.5-	11	6	2	4	1	2	3	11	17	22	39	14	22.9	26	42.6	12	19.5
GRANDRIVER AVE.	341	16′	6½″	CRUSHED COBBLES SAND	1-2½-5 1-2-3	1910	CLAY LOAM				59	64	20	13	29	36	46	36	154	149	303	102	29.9	167	49.0	65	19.1
GRANDRIVER AVE.	515	16′	7″	WASHED PEBBLES SAND	1-1½-3	1911	SAND LOAM				13	2	26	7	3	2	6	60	48	71	119	45	8.7	111	21.5	66	12.8
GRANDRIVER AVE.	1208	16′	7″	WASHED PEBBLES SAND	1-1½-3	1912	SAND LOAM	352	66.5-	33.5+	70	17	44	20	13	7	5	28	132	72	204	126	10.4	180	14.9	54	4.5
MICHIGAN AVE.	481	17′-8″	6½″	WASHED PEBBLES SAND	1-2-4	1910	CLAY LOAM	1009	67.5+	32.5	219	54	48	6	23	10	21	5	311	75	386	252	52.4	288	59.9	36	7.5
MICHIGAN AVE.	1570	18′ 16′	7″	WASHED PEBBLES SAND	1-1½-3	1911	SAND LOAM				219	77	80	38	42	24	14	9	355	148	503	311	19.8	415	26.4	104	6.6
RIVER ROAD	149	15′	6½″	WASHED PEBBLES SAND	1-2-4	1910	CLAY	538	78.9+	21.1-	49	11	5	0	6	3	2	12	62	26	88	57	38.3	72	48.3	15	10.0
RIVER ROAD	434	15′	7″	WASHED PEBBLES SAND	1-1½-3	1911	CLAY				165	27	17	18	13	27	0	7	195	79	274	184	42.4	224	51.6	40	9.2
RIVER ROAD	213	15′	7″	WASHED PEBBLES SAND	1-1½-3	1912	CLAY				14	4	8	8	4	3	0	8	26	23	49	21	9.8	52	24.4	31	14.6
RIVER ROAD	208	15′	7″	WASHED PEBBLES SAND	1-1½-3	1912	CLAY				17	7	9	21	0	0	0	1	21	29	50	25	12.0	44	21.2	19	9.2
FORT ST. ROAD	450	12′	7″	WASHED PEBBLES SAND	1-1½-3	1912	CLAY				0	1	19	11	9	1	1	31	29	44	73	27	6.0	66	14.7	39	8.8

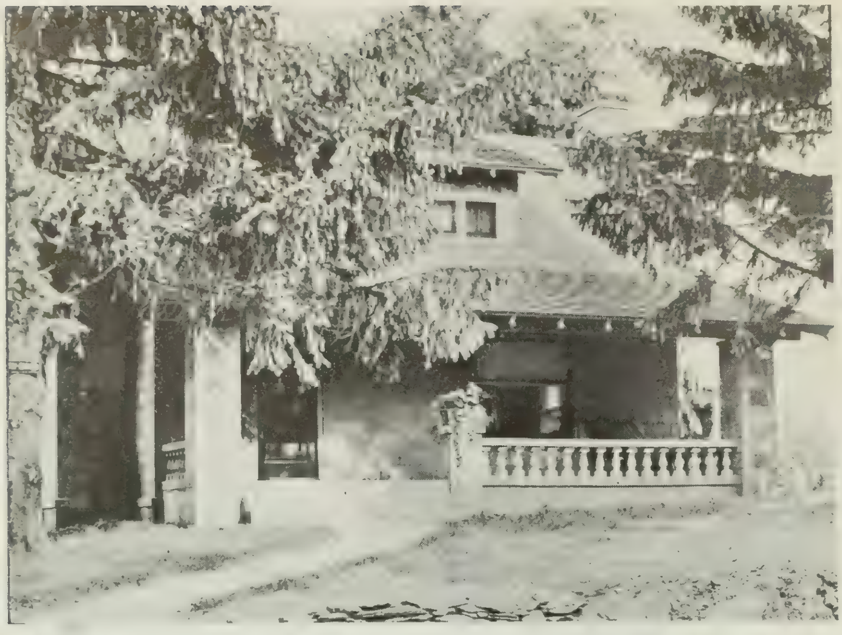


Fig. 1—Cottage Built by R. H. Bushnell, Poughkeepsie, N. Y., at a Cost for Concrete Work in Basement, Upper Walls and Porch, of $1,200

Attractive Concrete Block in Poughkeepsie House

The concrete cottage "Grey Hook" illustrated is in Poughkeepsie, N. Y. The concrete work erected cost $1,200. The block used are of the two-lug type, like those used in the house at Mooseheart, Ill., described elsewhere in this issue, but these were made in home-made wood molds. They are 3″ thick on the face with 5-in. lugs. The house was built under the direction of R. H. Bushnell for his own occupancy but was later sold.

An interior view of the wall under construction is shown in Fig. 3. This view shows the plugs to which furring strips were attached.

The basement walls are 13″ thick, of two-piece block; basement partitions are 6″ thick.

Figs. 4 and 5 show wall surface detail. Block have a scrubbed surface, exposing aggregates. A variety in the aggregates seems in excellent taste. Note the coarse texture of the basement wall in the lower part of Fig. 5 and the finer texture above and in the corner column of the porch note the contrasting tones of two different block faces and the system of laying.

Canvas painted with linseed oil has been recommended as a cover for rough forms. It is waterproof and would, therefore, not absorb water from the concrete; it would also prevent the leakage of the liquid mortar that occurs at cracks or joints in the wooden forms. It would probably be economical for the reason that it does not require planed boards in the forms and it could, no doubt, be used repeatedly. It would further help to keep the frost out of the concrete.

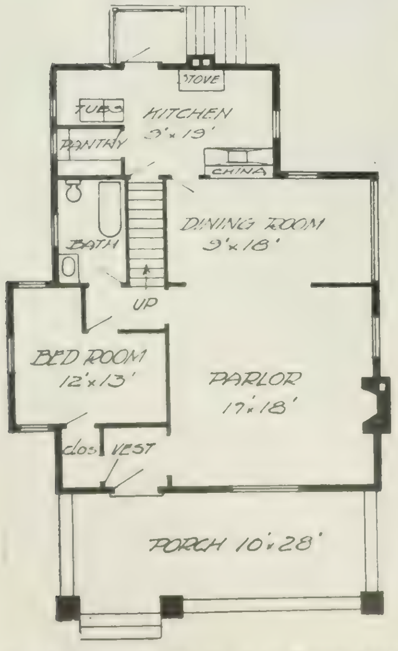


Fig. 2—First Floor Plan of Poughkeepsie House

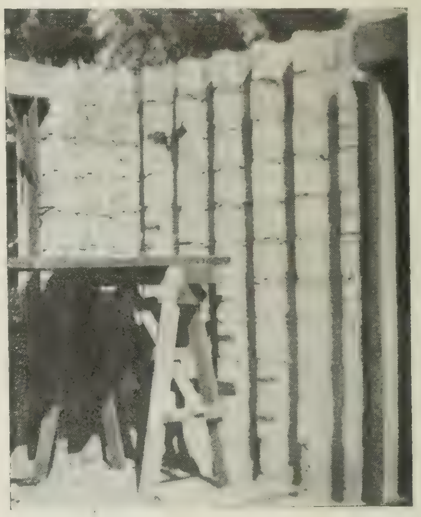
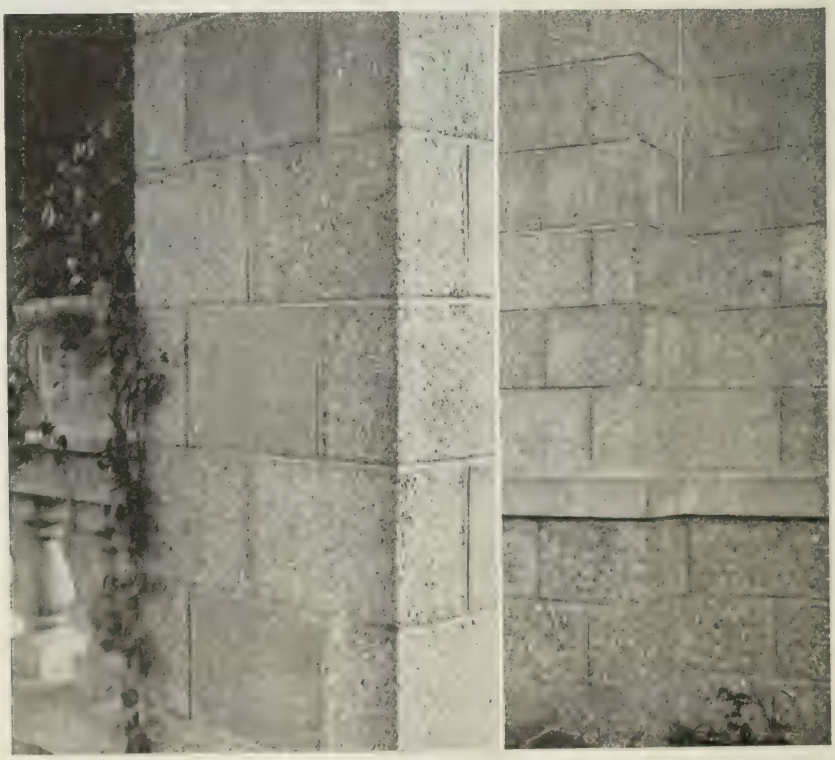


Fig. 3—Interior View of Block Wall Under Construction



Figs. 4 and 5—Detail of Porch Column With a Glimpse of Concrete Porch Balusters and a Detail of Wall at Chimney, Showing Contrasting Surface Finishes

The Concrete Fence Post Factory of the C. B. & Q. R. R. Co., Havelock, Neb.

By W. W. Eldridge[1]

The manufacture of concrete fence posts has been taken up quite extensively by the Chicago, Burlington & Quincy R. R. Co. with a view of eliminating the wooden post for right-of-way fence as much as possible. The rapid depletion of our forests has awakened the farsighted consumer of large quantities of fence posts to the necessity for a suitable substitute for the wooden post. There are a number of designs of steel posts bidding for public approval, but they are not yet commonly accepted as a fitting substitute; hence the concrete post is rapidly gaining favor as a suitable product to fill the vacancy caused by the passing of the wooden fence post.

It is generally acknowledged that concrete posts are not so strong as wooden posts; however, this does not necessarily detract from the qualities of the concrete post for the reason that it is generally conceded that they are sufficiently strong for the purpose for which they are intended, while the wooden posts are conceded to be of greater strength than is necessary. It is also a well known fact that concrete posts increase in strength with age, while the wooden post decreases in strength each year, due to the action of the soil and elements which propagate fungus growths that are a constant drain on its vitality and eventually cause decay.

On the Burlington we are using the National[2] post machine. This machine was purchased by us in 1909 and installed at Montgomery, Ill.; however, in the first year the manufacture was not pressed to any great extent. In the year 1911 this machine was removed to Havelock, Nebr., where it is still in operation, the annual output averaging 100,000 posts. This plant is under the direct supervision of our general storekeeper and the output controlled by him. The plant is operated throughout on a piece work basis, the Division Storekeeper at Havelock having full charge. Sufficient ground space has been allotted and permanent buildings erected and equipped with such facilities as will permit of the greatest efficiency, under existing local conditions, at the least possible cost to manufacture.

Fig. 1 shows a detailed plan of the plant. The building proper is a frame structure 28′ 6″ wide by 175′ long. As will be noted, this building consists of two compartments, one being the machinery room and empty form storage, 95′ long, and the other the seasoning room, 80′ long. The seasoning room is equipped with susitable racks against which to lean the full forms while the posts are seasoning sufficiently to be removed from the forms. The floor of the building is earth fill covered with cinders, except the cement storage rooms and a portion of the machinery rooms, which have a concrete floor. Around the inside of the building are heating coils (consisting of 6 pipes, $1\frac{1}{4}''$) in order that the process of manufacture may be successfully carried on in the winter months. Fig. 1 shows the relative position of the necessary machinery as follows: 1 upright boiler, 1 vertical engine, 1 hopper and feeder, 1 mixing and filling machine, 1 form straightener, 1 form cleaning bench, 1 reinforcement bench, 1 bin rack.

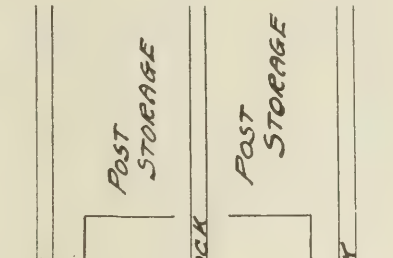


Fig. 1—Plan of Fence Post Factory

1, boiler; 2, engine; 3, hopper and feeder; 4, mixer and filler; 5, form straightener; 6, form cleaner; 7, reinforcing bench; 8, pin rack; 9, empty form storage; 10, reinforcing storage; 11, turntable

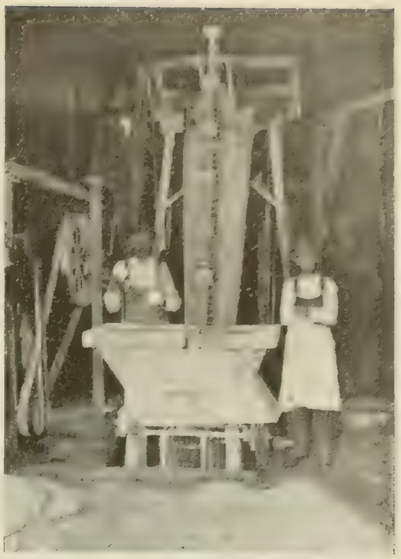


Fig. 2—Mixing and Filling Apparatus

The hopper and feeder and the mixing and filling equipment are part of the fence post outfit. The form straightener, cleaning bench and pin rack were locally made for the Havelock factory. The form straightener consists merely of a piece of round iron which is passed through the post form so that dents may be taken out by means of a hammer.

No doubt the most economical man-

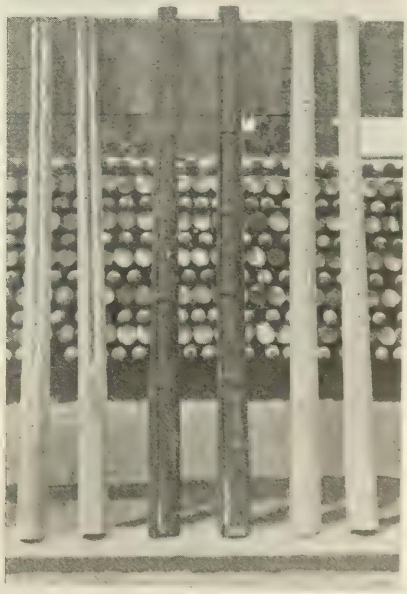


Fig. 3—Posts and Forms Showing Punching for Insertion of Pins

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[1] General Piece Work Insp., Store Dept.

[2] National Concrete Mchy. Co., Madison, Wis.

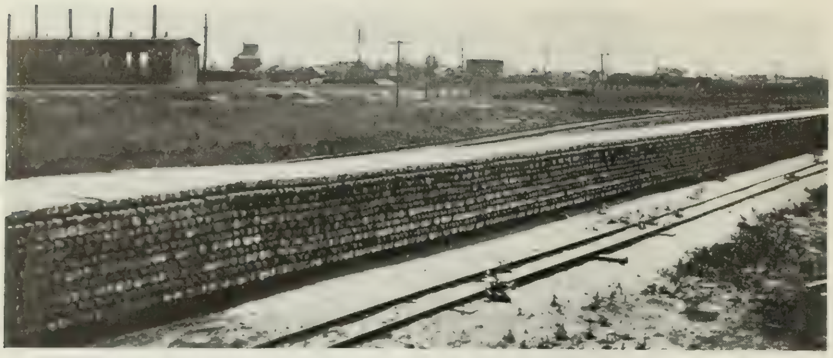


Fig. 4—Storage Pile Concrete Posts

ner of operating a plant of this kind is with a gasoline engine, but in our case the plant is isolated and such a great distance from our shop power house it has not been considered an economical proposition to pipe the steam such a distance; hence in order to insure radiation during the fall and winter months, to protect and season the posts, it became necessary to install an upright boiler in preference to a gasoline engine. This boiler furnishes all the steam for the operation of the machinery in addition to that required for radiation. The foreman of the plant is the engineer as well.

It will be noted that the plant is equipped with a narrow-gauge car track, running from the mixer and filler through the entire length of the building and outside to the extreme end of the storage yards on either side of it. Broad-gauge tracks are also located on either side of the plant and storage yards so that the posts may be loaded for shipment direct from the storage piles. Two thousand post molds have been provided in order that the posts may remain in the forms or molds long enough to season to a point where they can be removed with safety.

The complete working force of the plant is as follows: 1 foreman and engineer, 1 man wheeling sand to the hopper, 1 man feeding hopper with sand and cement, 1 man operating mixer and filling machine, 1 man setting empty forms in machine and taking out full forms, 1 man taking full forms from the filling machine to the seasoning room, 1 man cleaning forms, 1 man making and placing reinforcement, 2 men setting pins and 3 men taking posts out of forms and storing them.

We have experimeted with different reinforcement, viz: sheet iron, five-wire and six-wire, and laboratory tests which have been made of the finished product show the posts with the six-wire reinforcement to be the strongest, hence we have adopted this as standard.

We have also experimented with several ingredients in order to obtain the best mixture possible consistent with a reasonable cost per post, such as screened gravel, stone dust and clean, sharp, washed sand. The result of our experiments has been that the washed sand mixture gave us a post of greater tensile strength than either of the other ingredients. We are using a 1:4 mixture, or approximately 7 sacks of cement to 1 cu. yd. of mixture.

The post which we are making is 7′ long with a 3½-in. top and 4½-in. butt, and has 13 pin holes so as to permit of the application of any one of several different styles of fence which we use. The pin holes are made with a steel pin ¼″ in diameter on one end and ⅜″ on the other with a shoulder or offset between the two diameters. These pins are made in various lengths so that the shoulder offset in each hole will be the same distance from the outside surface of the post. The object of this shoulder is to hold the wire fastener, which in our case is a common 10d wire nail, the head of the nail resting against the shoulder to prevent it pulling through the post, and the point being twisted around the wire. A suitable tool is provided for applying this style of fastener. We have found this fastener very satisfactory and prefer it to any other fasteners which have so far come to our notice.

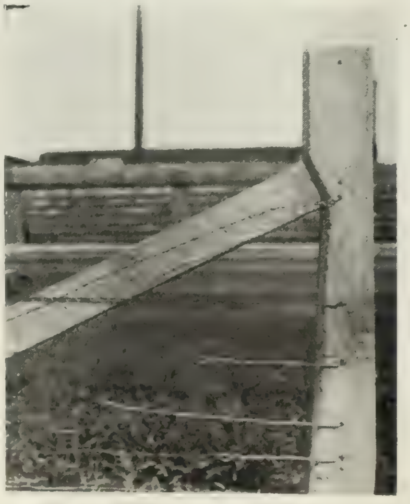


Fig. 5—Corner Post and Brace

In the operation of the plant each mold is cleaned and oiled each time it is filled to insure a smooth surface on the post and to prevent the concrete from sticking to the molds. The empty molds pass first to the straightener, providing they need repairs; from here they pass to the cleaning and oiling bench, then to the reinforcement bench, where the reinforcements are inserted in the molds, and then to the pin bench, where the pins are properly placed. The molds are then ready for filling and are passed to the filling machine.

The sand is unloaded just outside the building by means of a Gantry crane and clamshell at a very small cost. This sand is then wheeled into the building as required and dumped on the floor in front of the hopper. The man in charge of the hopper feeds the sand and cement into separate hoppers. The mixture is regulated by means of a winding shaft or worm gear to the proper proportions of each ingredient. From the hopper the dry mixture is conveyed into the mixer and filling machine by an endless chain fitted with elevator buckets. The man in charge of the mixture sees to it that the ingredients are properly mixed, after which the mixture is fed into the molds, and while being filled the molds are violently agitated to insure the proper density.

After being filled the molds are removed from the machine and placed on a narrow-gauge rubble car in a vertical position—the car being equipped with a rack—and taken to the seasoning room. As soon as the concrete has set sufficiently to permit the pins to be withdrawn without distorting the holes, this is done. The posts are then allowed to remain in the molds from 30 hrs. to 60 hrs., depending upon weather conditions, to permit the concrete to harden, and are then removed from the molds and taken to the storage piles on rubble cars to finish seasoning. While passing through the seasoning stage in the storage yard the posts are sprinkled once or twice daily for a week to prevent them from checking and to assist in the final seasoning. This is important.

The plant has a capacity of 10,400 posts per mo. of 26 working das. when working 10 hrs per da. It is not advisable to operate the machine at too great a speed, for in so doing the ingredients will not be properly mixed, neither will the proper density of the mixture in the molds be possible. An output of 40 posts per hr. will insure good results. The accompanying illustrations show the post in detail; the kind of molds, as also the manner of storing for final seasoning. Each tier is stripped to allow free circulation of the air on all sides of the posts so that the seasoning will be uniform. The longer the posts are allowed to season the better, and in no case should they be handled in less than 60 das.

In connection with the manufacture of the standard fence post we are also making a combination corner and gate post and a brace, as shown in the accompanying illustration. Two 1-in. pipe ferrules are inserted in the post for the application of the gate hinges. These corner and gate posts are well adapted for the purpose for which they are intended; however, on account of their bulk and cost to manufacture they are not entirely satisfactory, but not having knowledge of any other style of corner and gate post that is suitable and can be produced for less money, we must be contented for the time being. We are making further experiments on corner and gate posts which we hope will be productive of good results.

In setting posts along the right of way we experienced considerable dif-position in soft and swampy ground, ficulty in getting them to hold their hence it became necessary to provide something that would hold them in place, and we are making a concrete post anchor for this purpose. This anchor has a tapered hole of the same taper as the post, is 6″ thick by 10″ x 12″. The size of the hole is such that when the anchor is slipped over the top of the post it comes to rest at a point just below the ground line. This anchor has proven very satisfactory for this purpose.

Materials necessary to make 100 posts are: 19.8 sacks of cement, 2.3 cu. yds. washed sand, 100 six-wire reinforcements.

The following result of laboratory test can be made on posts with different reinforcement is also quite interesting.

It is commonly conceded that the average life of a cedar fence post is 15 years, and while we know of no concrete posts that have been made long enough to give definite figures, at the same time it is claimed that a conservative estimate of the life of a concrete post would be 40 years, and that being the case it will be readily seen that the concrete post is an economical proposition even at an increased first cost of 15% to 18%. Posts are costing us 21 cts. each in the storage pile.

A plant as described above can be erected and equipped for approximately $6,500, exclusive of the land and crane. A crane is not necessary for the operation of a post factory, but as we have one convenient for handling concrete piling and slabs we utilize it for unloading sand for making fence posts.

Concrete at the Scene of War

One of the most interesting developments of the European battle field is the constant use of concrete in its various forms by the two contesting armies. Hardly an account of a battle comes but contains some account of the use of concrete. Here and there foundations for guns are discovered to have been built years before the war in advantageous positions to enable the Germans to mount their great guns in convenient points, In other places it is found that guns are dragged to the front of the battle line are rapidly mounted upon foundations built of concrete made with quick-setting cement. The trenches, too, are not free from cement, as the accounts of the men living from day to day in these trenches contain also accounts of the use of concrete to fortify the trenches and make them dry for the soldiers at the front. Large orders for cement have been in the market in Europe for all the battling armies and no army is considered properly provided that has not its cement supply ready for work at a moment's notice. Where "Old Hickory" battled with the English behind ramparts made of bags filled with sand and bales of cotton, the modern soldier is protected by concrete in his trenches and when all remedies fail, carloads of cement are rapidly emptied and the cement in sacks is piled in front of the soldier and protects him from the enemies' fire.

Test of Concrete Posts—Sheet Iron vs. Wire Reinforcement

Post No.	1	2	3	4	5	6	7	8
Description	Reinforced with six wires .162″ in diam.				Marked Reinforced with No. 24 corrugated sheet iron Thickness .022″ to .024″		Marked Reinforced with No. 26 corrugated sheet iron Thickness .022″ -.023″	
Date made	8-31-12				8-31-12		8-31-12	
Date tested	12-11-12				12-11-12		12-11-12	
Age	102 das.				102 das.		102 das.	
					lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Wt. reinforcement	2 lbs. 14¼ ozs.				4 4	4 5	3 13½	4 5½
Wt. in lbs.	81½	83½	79	83½	86	81½	84	81½
Diam. at bottom	4¾	4¾	4⅝	4¾	4⅝	4½	4⅞	4⅝
Diam. at top	3 5-16	3 11-32	3¼	3 5-16	3 5-16	3 5-16	3 5-16	3⅜

Transverse Test—6 Ft. Centers

					.00″	.00″	.00″	.00″
Initial load 50 lbs.	.00″	.00″	.00″	.00″	.00	.00	.00	.00
Deflection at 100 lbs.	.00	.04	.05	.05	.05	.06	.04	.05
150	.02	.08	.11	.09	.10	.11	.09	.10
200	.10	.12	.15	.13	.15	.15	.19	.15
250	.12	.16	.20	.17	.19	.20	.28	.20
300	.18	.20	.24	.21	.24	.25	.36	.27
350	.23	.25	.31	.27	.28	.30	.48^3	.36
400	.31	.30	.36	.32	.34	.37	...	.45
450	.35	.35	.42	.35	.40	.44	...	.58^3
500	.40	.39	.48	.38	.49	.54^3	...	...
550	.48	.45	.56	.43	.59	...	...	...
600	.56	.50	.64	.48	.82^3	...	...	...
650	.63	.57^3	.76	.53	...	...	...	...
700	.74	.64	.87	.58	...	...	...	...
750	.85^3	.70	1.00^3	.63	...	...	...	...
800	...	.76	...	.71	...	...	...	...
850	...	.87	...	.78	...	...	...	...
900	...	...	...	.89	...	...	...	...
950	...	...	...	1.01	...	...	...	...
Failed at (lbs.)	800	890	790	990	600	550	390	500

One of the results of the better construction of concrete roads and the increased knowledge in connection with their building is brought out in a recent article in the *Chicago Tribune*. It appears that a firm of contractors had been employed to construct three miles of concrete road on Archer Ave., one of the Illinois state aid roads. The county superintendent of highways refused to accept the road on the ground that the contractors had failed to stop work on the road after being ordered to discontinue when cold weather arrived. When the order was given to stop work on all concrete roads, there were only 1,500′ of the three miles in question remaining to be completed. Of the concrete, but 400′ of road was constructed on frozen ground and it was for this reason that the superintendent declined to accept the work and very properly, too, for certainly road construction on frozen ground is worse than no construction at all. Years ago, before the diffusion of knowledge in connection with the proper construction of concrete roads, work of this kind would have been accepted and the results as usual blamed upon concrete. Nowadays, things are different and with greater knowledge produced.

Brushed Concrete Balustrade Along Erie Canal, Rochester, N. Y.

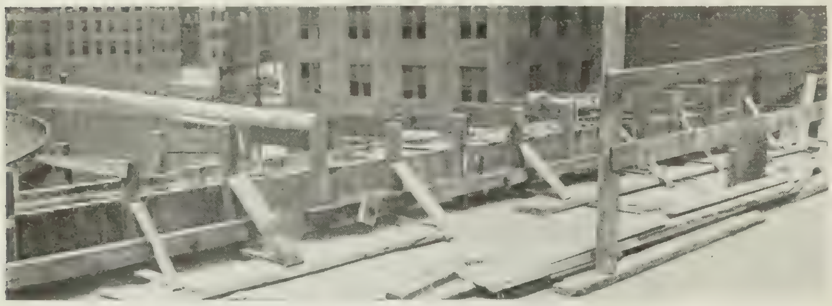


Fig. 1—Shows Forms in Place for Base Rail of Balustrade

The accompanying illustrations show the balustrade under construction and completed in South avenue, Rochester, N. Y., along the bank of the Erie canal.

There are 400′ of this construction consisting of pre-cast balusters and cast-in-place top and bottom rails, all with brushed finish.

The spindles were made in cast iron molds made especially for the job, and contain 4 parts of Hardwick, Vt., granite, 1 part of washed sand and 1 part of Cayuga Portland cement. The base rails and the top rails were made in wooden forms which were oiled before being filled with concrete.

On account of the extremely hot weather when the work was done, the contractors did not place the concrete in the forms until late in the afternoon. In the morning the forms are removed and the work scrubbed with steel brushes. It was necessary that the scrubbing should be done immediately after the forms were removed, as the surface hardened quickly when exposed to sun and air. The work was first scrubbed dry to remove any rough parts from the surface and then were scrubbed wet. In order to complete the scrubbing as soon as

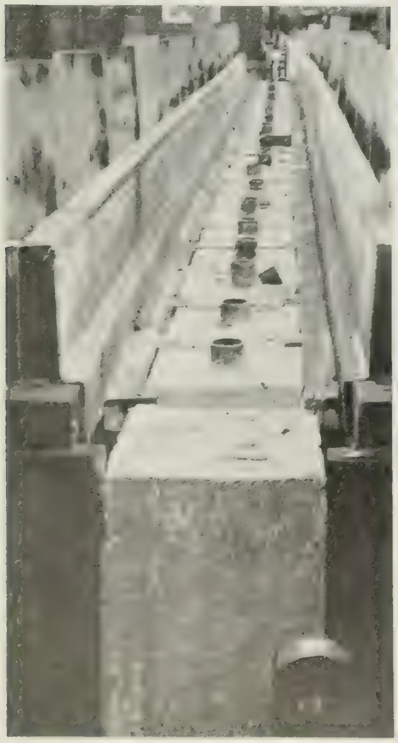
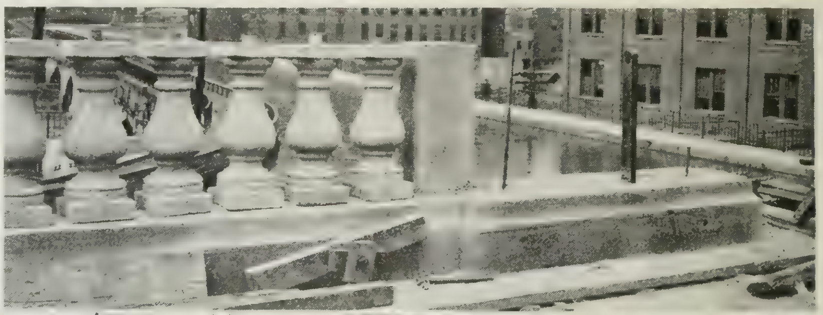
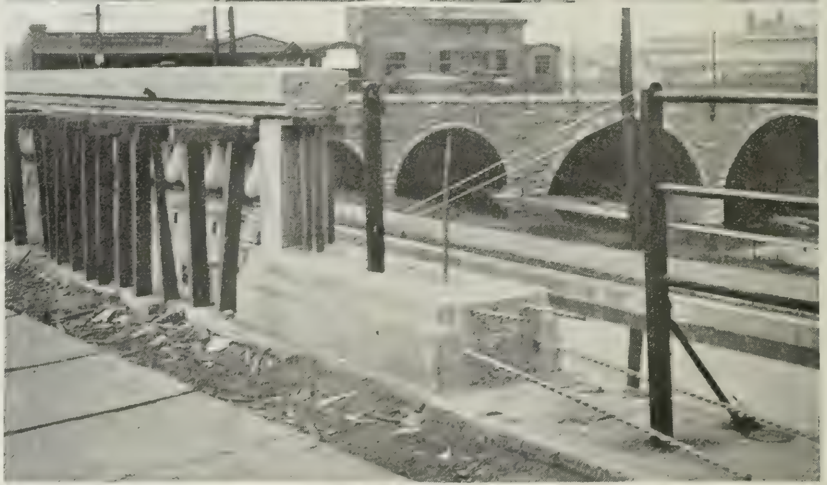


Fig. 2—Shows Forms for Top Rails

The round irons show how the balustrades are fastened into the top rail. The irons are later filled with concrete. Note strips of wood between alternate spindles for blocking; the cracks and little openings in wood are filled with clay to prevent concrete from running onto the finished work below





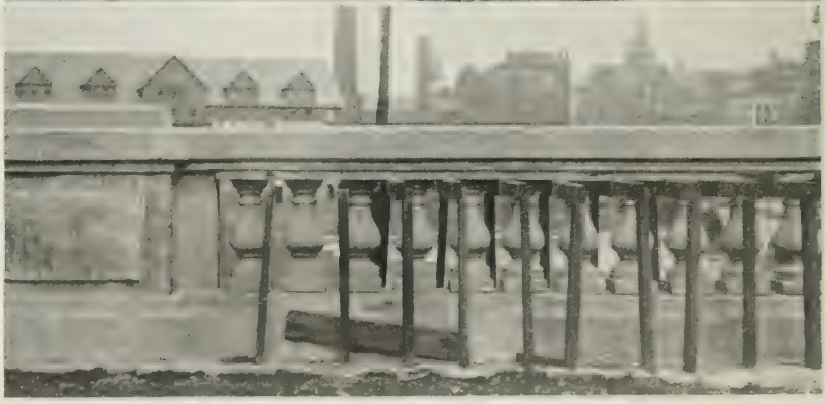


Fig. 3—Shows Base Rail Complete and the Balusters in Position, and the Bottom of One Post, Showing the Iron Anchor

Fig. 4—Shows Section of Balustrade After Removal of Forms, Also Shows Reinforcement Used

Fig. 5—Shows Work at Same Stage as Fig. 4 from Different Position and One Post Complete

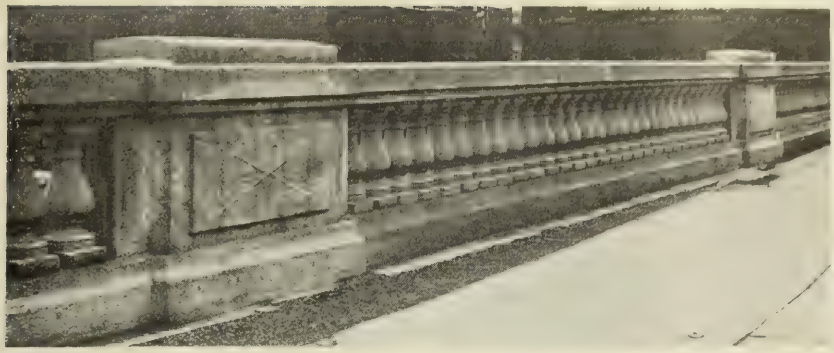


Fig. 6—Shows Finished Balustrade from Sidewalk, Bush-hammered

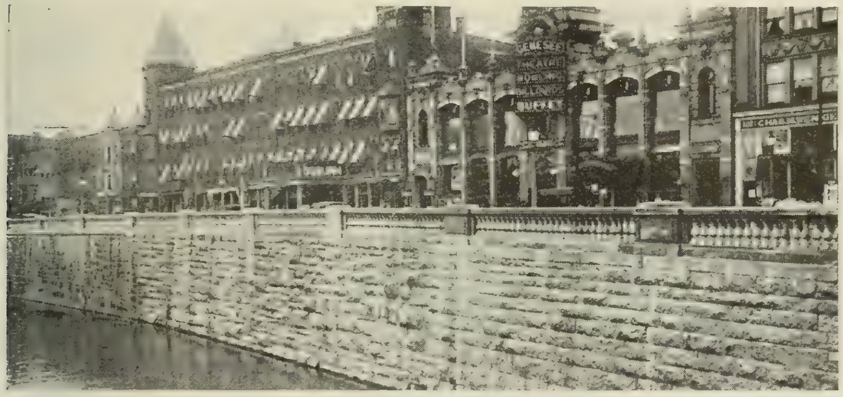


Fig. 7—Finished Balustrade, View from Across the Canal

possible it was necessary to place an extra force on this particular work. The scrubbing of the surface of the rails, cost about 2½ cts. per sq. ft. but four men could make and scrub only 10 of the spindles in a day. After scrubbing and when hard the base and the rail were bush-hammered. This was done a week after scrubbing. This final finish brought out the granite effect and this cost 15 cts. per sq. ft.

The contractors experienced no trouble from cracking between the spindles and the top rail, with but one exception, where the steel reinforcement of the rail extended into the post, resulting in a crack in the center of the top rail. This trouble was eliminated in the next section of rails by running the steel reinforcement up to the post and placing two layers of tar-paper between the rails and the post for the purpose of taking care of expansion.

The work was done by Whitmore, Rauber & Vicinus, contractors, Rochester, and the data are supplied by Mr. Rauber.

Care must be taken to prevent work from being thrown out of plumb by swelling of lumber in forms. If the forms spring out of place the concrete may flow out and be wasted; and, at best any springing of the forms will injure the appearance of the surface of the finished structure.

A Concrete Cooling Box

A simple and inexpensive convenience on the farm having no cellar is a cooling box made of concrete. Paul Roeder, Rocky Ridge, Ohio, has constructed one which is proving a success and several of his neighbors are following his example.

The cooler, shown in the accompanying illustration, is 8′ long, 3′ wide and 2′ deep, with walls 4″ thick. At each end is an opening for a water pipe about 6″ from the top. Water from a pump is run into the tank and when filled to the overflow, it passes through the opposite end to a watering trough, where all the stock is watered. In this manner, fresh water is pumped into the cooler at nearly all hours of the day, and the milk, cream and other products are kept from spoiling.

The cooler required 1½ bbls. of Portland cement at a cost of $1.55 per bbl. and 1 ton of sand at 75 cts. per ton. The forms were made from old lumber. A shed will be erected over the cooler, thus affording protection from the weather.

A Simple and Inexpensive Concrete Cooling Box

Surface Imperfections

Imperfections in the exposed surfaces of concrete are usually due to one or more of 10 well known causes, as follows:

(1) Variations in the nature of the cement, sand or stone;
(2) Lack of uniformity in the amounts of ingredients in each batch;
(3) Insufficient mixing in any or all batches of concrete;
(4) Lack of care in placing the concrete next to the molds;
(5) Lack of proper protection in placing concrete;
(6) Efflorescence and discoloration of the surface;
(7) Unsightly construction joints;
(8) Imperfectly made forms;
(9) Dirt on the forms;
(10) Adhesion of forms.

The ends of reinforcing bars which are left protruding for splicing should be, if they are not likely to be connected up for some time, painted with some paint to diminish rusting and to guard against being bent or loosened.

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field. □ □

Construction of Sanitary Mangers in Dairy Barn at Troy, Pa.

There has been recently completed at Troy, Pa., a large L-shaped dairy barn, 70′ x 102′ in plan, wherein sanitary mangers have been installed, as shown in Fig. 1. The entire floor is of concrete, mixed in the proportions of 1:2:4. The method of construction is described as follows:

LOCATING FLOOR LEVELS

The floor levels were first established, and the ground leveled off or filled up to correspond with these grades, but about 6 in. below the finished floor levels. Care was taken not only in getting the proper drainage of the mangers and gutters, but also in getting the proper grades to correspond with the outside approaches.

Fig. 2 shows a partial cross-section of the floor. It will be noted that the litter alley floor on which the cows must travel to and from the stalls is practically on a level with the door sills over which the cows must pass. It has a slight slope toward the gutter.

Stakes similar to the one shown in Fig. 3 were used in leveling the ground, the notches corresponding with the different levels. They were set in rows about 20′ apart across the stable floor with three or four stakes in a row, equally spaced. Lines stretched on these stakes were held securely in place by the notches. If preferred, the notches can be sawed in the stakes after they are driven, care being taken to mark and saw the notches the right distances apart. Marks may also be made on the walls to assist in getting the levels.

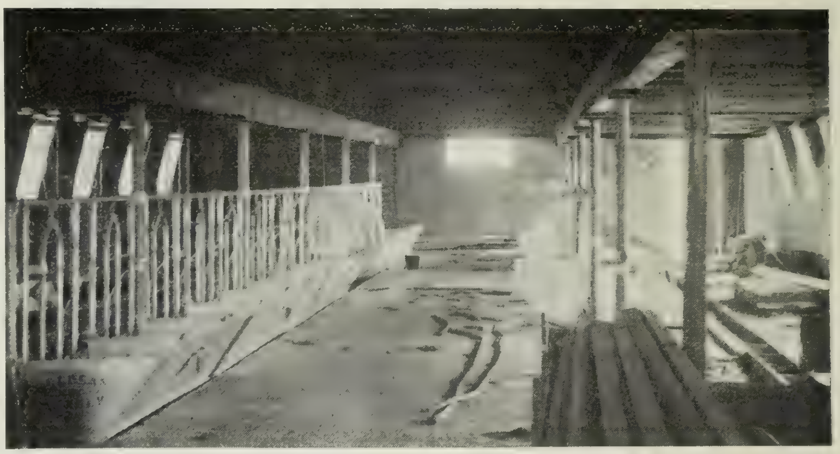


Fig. 1—Sanitary Cow Stalls and Mangers Erected at Troy, Pa.

SETTING UP THE STALLS

The sections of the top-rail of the stalls were first connected to the stall posts and then to the stall partitions. The lower ends of the stall posts were set 4″ below the level of the finished stall floor, and the lower end of the stall partitions 5″ below this level, as shown in Fig. 4. Where the dirt level was correct the stall partitions were blocked up 1″ and the stall posts 2″, otherwise thicker blocking of pieces of tile or flat rock had to be resorted to. A chalk-line was now stretched along one side of the row of stalls nearest the lower end of the posts, which were adjusted to this line. The stall posts were then plumbed in both directions, and the top rail made level with the drainage grade of the manger. The couplings were then tightened up, and three or four shovelfuls of cement mortar were placed around the lower end of each stall partition and every second or third stall post and allowed

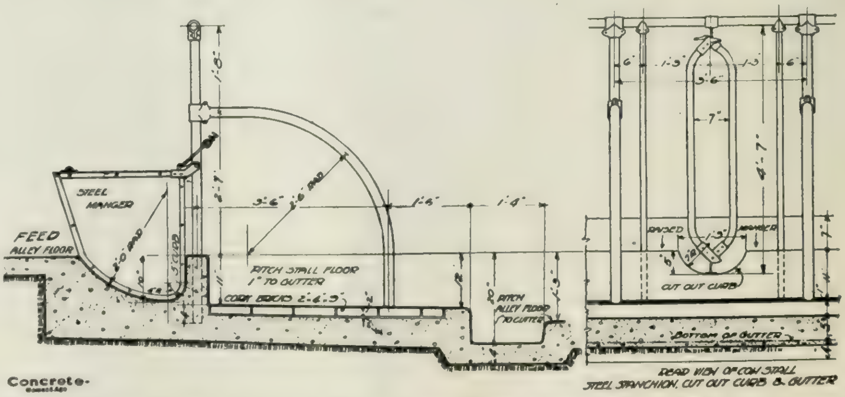


Fig. 2—Cross-Section Showing Feed Alley Floor, Stall Floor, Etc., and Rear View of Cow Stall, Steel Stanchion, Cut-Out Curb and Gutter

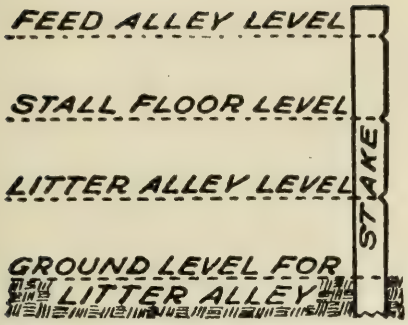


Fig. 3—Setting Grade Stakes

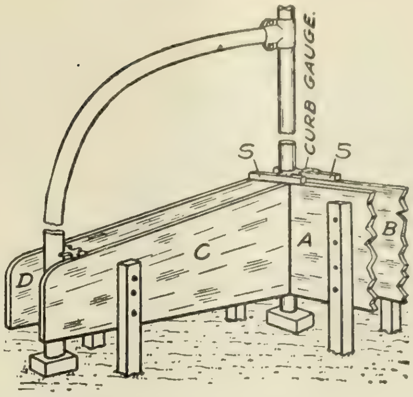


Fig. 6—Forms for End Curb

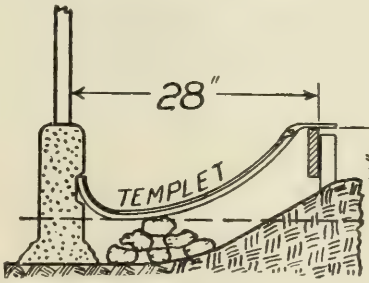


Fig. 7—Sketch Showing Method of Setting Templates for Manger Construction

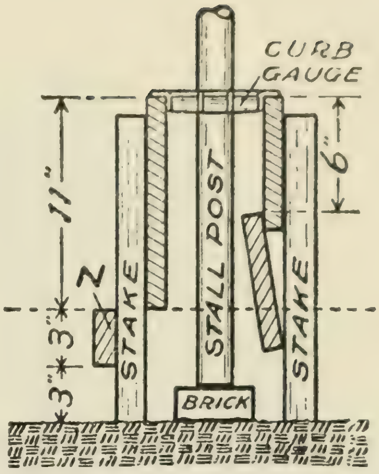


Fig. 8—Alternate Method of Constructing Groove in Curb

to set sufficiently to permit holding them accurately in place while the concrete was being put in.

CONSTRUCTING THE MANGER CURB

Before putting in the forms for the manger curb, care was taken to see that all drain tiles, water supply pipes and other pipes which were to be set in the concrete were in proper place and successfully tested out.

Form boards for the high cut-out curb, shown in Fig. 5, were then set up, using either boards 13″ or 13½″ wide, two 7-in. boards or one 6-in. and one 8-in. board, which, when placed together, would be at least 13″ wide. Inch lumber was largely used. The stakes were about 2″ x 2″ and 2′ 6″ long.

These boards were set on each side of the stall posts, as shown in Fig. 4, and a curb gauge placed at every post, being fastened with nails or screws to the upper edges of the boards, as shown. These gauges held the boards at equal distances on each (5″ in the clear), and they also held the board at equal distances on each side from the stall posts, requiring no measuring and saving the cutting of cleats, etc., to hold the boards in place.

After blocking the boards up until their upper edges are 14″ or 15″ above the dirt level, stakes were driven close to the boards every 3′ or 4′ apart, care being taken to see that they were evenly pointed and driven straight so as not to crowd the boards out of position. The boards were then raised until their upper edges were 4′ 2″ below the under side of the top-rail (see Fig. 4). This was done by cutting a stick 4′ 7″ long and setting one end on the upper edge of the form boards and allowing the other end to come up against the under side of the top-rail. The boards were then tacked to the stakes with 6d nails. The next and last thing is to set the cut-out forms, with stanchion anchors attached, in between the form boards, so that the anchors will be exactly in the center of the stalls.

Fig. 6 shows how the forms for the end curb were set. The regular form boards *A* and *B* were set in the manner described above, except that the board *A* is cut off 6″ shorter where

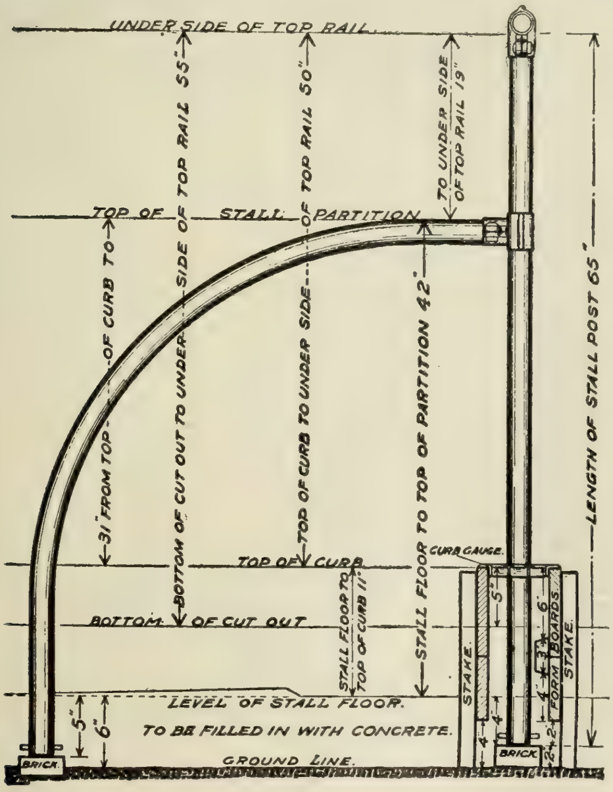

UNDER SIDE OF TOP RAIL
BOTTOM OF CUT OUT TO UNDER SIDE OF TOP RAIL 55″
TOP OF CURB TO UNDER SIDE OF TOP RAIL 50″
TO UNDER SIDE OF TOP RAIL 19″
TOP OF STALL PARTITION
31″ FROM TOP OF CURB TO
STALL FLOOR TO TOP OF PARTITION 42″
LENGTH OF STALL POST 65″
TOP OF CURB
CURB GAUGE
BOTTOM OF CUT OUT
STALL FLOOR TO TOP OF CURB 11″
LEVEL OF STALL FLOOR
TO BE FILLED IN WITH CONCRETE
GROUND LINE
STAKE
FORM BOARDS
STAKE
BRICK
BRICK
5″
6″

Fig. 4—Lining Up the Stalls

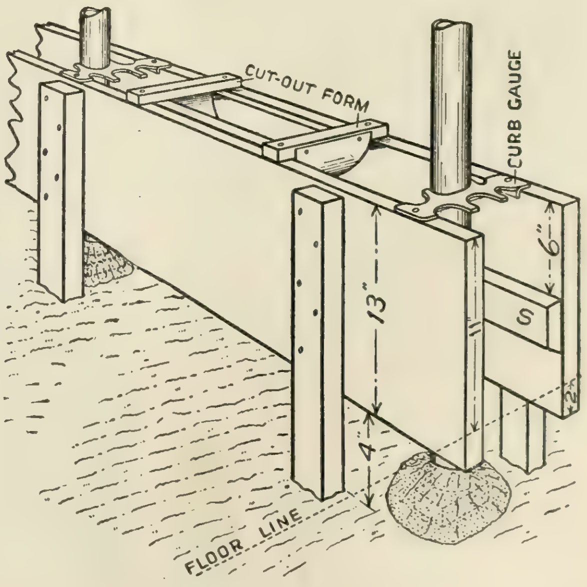


Fig. 5—Forms for High Cut-Out Curb

1-in. plank is used. Where the boards *C* and *D* for the end form were thicker or thinner the thickness of the inside board *C* was added to 5″ and the board *A* cut off that much shorter. This was necessary in order to make the thickness of the end curb 5″. The boards *C* and *D* were made long enough to extend out 2″ or 3″ beyond the stall partition. The board *C* was so cut that its inner end came flush with the inner side of the board *A* and was nailed on the end of this board.

The board *D* was nailed on the end of the board *B* and its adjacent end left any length desired. The curb was tapered down to make it 5″ or 6″ high above the stall floor at its outer end, and rounded off.

The inside curb gauge was set by tacking on two little strips *S*, one on each side, as shown in Fig. 6, and the curb gauge set on these strips.

The concrete for the curb was mixed in the proportions of 1 part Portland cement, 2 parts sand and 4 parts broken stone. The same proportions were also used through the entire job.

CONSTRUCTING THE MANGER

The manger shown in Figs. 1 and 2 was constructed as follows:

The form boards were about 6″ wide and the stakes 18″ long. Fig. 7 shows how far the inner side of the stakes were set from the adjacent sides of the stall posts and the height of the upper edges of the form boards above the stall floor level. One-in. boards well fastened to the stakes in a somewhat similar manner to that described for the curbs were found to answer for the shallow manger.

A space of from 2″ to 4″ was left between the lower edges of the form boards and the ground so as to allow the concrete to spread out at the bottom and form a better support for the manger and a better bond with the concrete of the feed alley floor.

Templates were set up as shown in Fig. 7 with the flat perforated part of the malleable castings on the upper edge of the form boards and fastened with short nails or screws, their lower ends resting in the groove in the adjacent side of the curb (see Fig. 4) and supported in this position by broken rock, as shown in Fig. 7, or by concrete already placed in the bottom of the manger. They were set from 3′ to 4′ apart—one for each stall, opposite the partitions. In setting them a level was used to insure the proper grade of the manger. Care was taken to see that the lower bent ends of the templates were held even or flush with the side of the curb immediately above the groove and close up to its upper edge. This was necessary to make the manger smooth and true. If a groove had not been made in the side of the curb, pockets would have to be cut to receive the ends of the template which stand flush with the curb and 5″ above the level of the stall floor.

Fig. 8 shows another and possibly a better way of making the groove inside of the curb next to the manger. Instead of using the cleat *S* shown in Fig. 5, the form boards are lapped as shown. It also shows an improved plan for joining the stall floor to the curb. A narrow board or strip *N* is nailed to the outer sides of the stakes so that its upper edge will be even with the line of the finished stall floor. The board on that side of the form is made 2″ narrower so that its lower edge will be on a level with the upper edge of the strip *N* instead of 2″ below stall floor level as usually set.

A straight-edge long enough to reach from one template to the other and lap over a little is used to prodce a smooth surface. The workman stands outside of the form boards and reaches down to the curb and draws the straight-edge toward him.

When the concrete had set sufficiently the templates were removed and the recesses formed thereby filled with cement grout, being very small as the templates were made of 1-in. x 1-in. x 1/8-in. T-shaped steel.

A curved trowel was used in order to avoid sharp corners both outwardly and inwardly projecting, and also to fill up cracks or crevices.

The Louden Machinery Co., Fairfield, Ia., furnished the sanitary cow stalls and mangers, and C. J. Case, Troy, Pa., was the contractor.

A New Portable Excavator for Light Excavation and Sand and Gravel Handling

A new type of truck mounted excavator, designed for handling sand and gravel and for trench work, cellar digging and light excavation generally, has recently been put on the market by the John F. Byers Mach. Co., Ravenna, Ohio. It has a digging capacity of 20 cu. yds. per hr. and in actual work has shown much higher records.

As described by the makers, and as shown by the accompanying illustration, the excavator will handle a 1/2-cu. yd. clam-shell or orange-peel bucket on a 20-ft. to 22-ft. boom with a range of hoist up to 12′. Except the boom, which is of wood, the construction is steel and steel outriggers are provided to prevent tipping sideways. Where conditions do not permit the use of outriggers, guy ropes can be substituted.

The 8-h.p. engine is vertical, double cylinder and geared, giving a rope pull of 4,200 lbs. at a speed of 100′ per min. The boiler is 32″ in diamete, 70″ high, and has 55 2-in. tubes, 43″ long.

All other parts, such as wire rope, blocks, fittings, etc., are the manufacturers' standard, except the digging bucket, which may be any make preferred by the purchaser.

The machine has a total weight, without bucket, of 7 1/2 tons, and is transported by team, the pole, neckyoke and single and double trees being furnished as part of the equipment.

Sea sand contains alkaline salts that attract and retain moisture and cause efflorescence.

BYERS LIGHT PORTABLE EXCAVATOR

A Small Batch Mixer with Special Loading Feature

Several improvements of value in its line of small concrete mixers—the Atlas—are announced by the manufacturer, Atlas Engineering Co., Milwaukee. The most important of these is the rapidity with which the mixer can be loaded and handled, it being claimed that the mixer gives a 2½ cu. ft. batch per min.

As described by the makers, and as shown in Figs. 1, 2 and 3, the drum is made of heavy boiler plate with gray iron heads, the outer edges of which form tires upon which the drum rolls. The mixing blades and buckets, shown in Fig. 3, are made of heavy boiler plates and are held in place in the drum by hand-forged brackets, machine-riveted to the drum. The blades are set ¾″ from the drum, thus permitting the water used in cleaning to pass under the blades and also preventing the setting of concrete behind them.

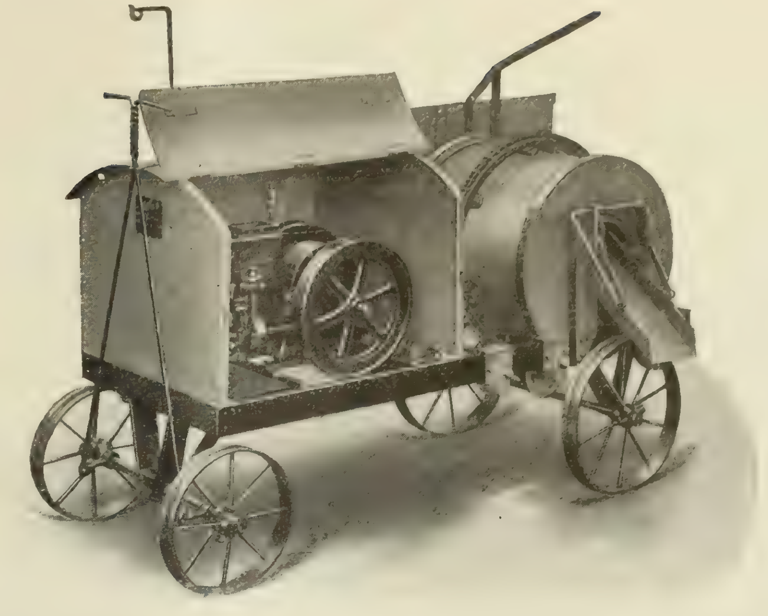


Fig. 2—View Showing Gasoline Engine and Discharging Device for the Atlas Mixer

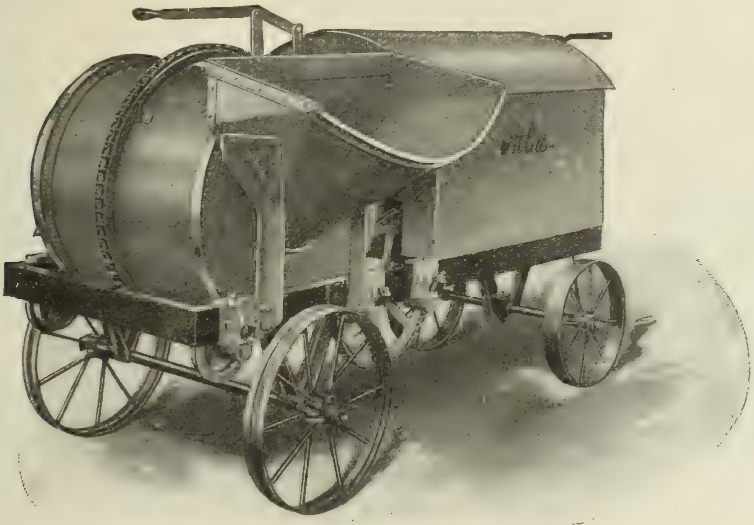


Fig. 1—View Showing Loading Device for the Atlas Mixer

The clutch is of the expanding ring type, being provided with grease cups at the various points where required. It starts the drum with a very slight pressure of the lever.

The gasoline engine shown in Fig. 2 is built especially for the Atlas mixer by the Christensen Engineering Co., Milwaukee. It can be operated in all kinds of weather, as it is completely covered by a metallic hood.

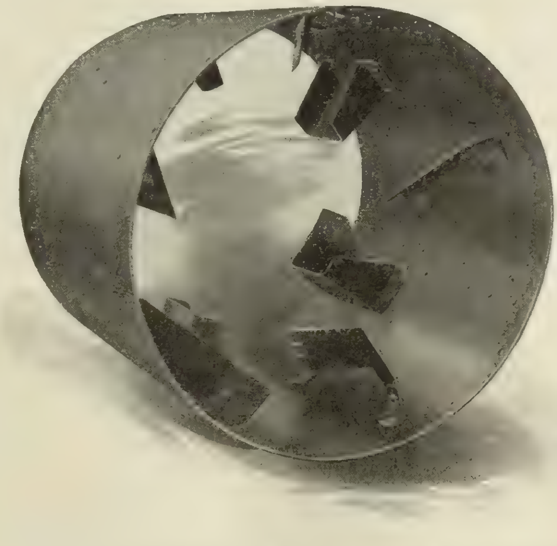


Fig. 3—Arrangement of Mixing Blades and Buckets in the Drum of the Atlas Mixer

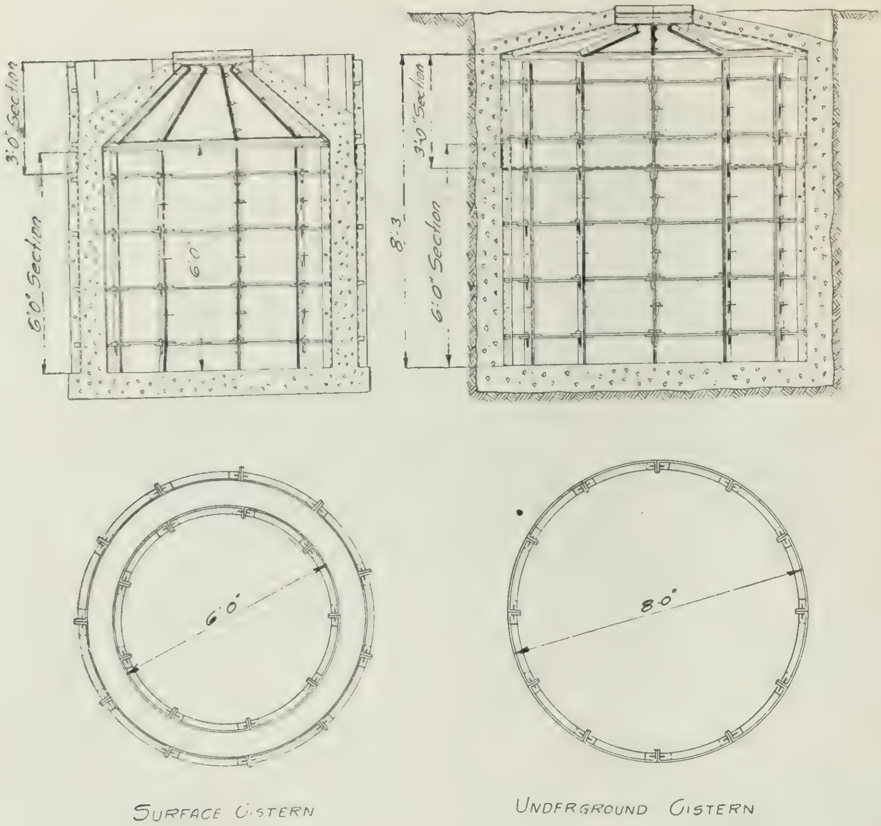
A New Type of Adjustable Cistern Form

One of the recent inventions in the concrete industry is a new type of steel cistern form which is being furnished by the Blaw Steel Construction Co., Pittsburgh. It is an adaptation of the same principle employed in the Blaw adjustable circular column molds, which have been on the market for a number of years.

As described by the makers, and as shown by the accompanying illustrations, the forms may be used for cisterns either above or below the ground. For cisterns beneath the ground, an excavation is made of the proper diameter and the earth outside usually acts as the outside form, the inside form only being required. Two sets of forms are required for cisterns above ground.

The panels which compose the straight portion of the form are slightly flexible, so that they may be bent to different diameters. These are kept in proper curvature by sectional bands which pass through the flanges of the panels and are secured by keys on each side of the flanges. A separate set of bands is necessary for each size of cistern, but the panels may be used for all sizes from the smallest to the largest, more panels being introduced when the diameter of the cistern is larger.

In order to secure the same adjustment for the cover form as that of the straight portion with respect to varying diameters, the slope of the roof on the top portion becomes steeper as the diameter of the cistern decreases, as will be seen from the accompanying illustrations, the same



SURFACE CISTERN

UNDERGROUND CISTERN

THE BLAW CISTERN FORM

type of form being used for either the 6-ft. or the 8-ft. cistern, except that in the case of the larger cistern a few more panels are introduced.

These forms will handle cisterns of any desired capacity. A cistern 6′ in diameter and 6′ high will hold about 40 bbls. Introduction of one additional panel in the side form, making the diameter 6′ 8″, increases the capacity to about 50 bbls. Introduction of three additional panels, making the diameter 8′, increases the capacity to about 70 bbls. When it is desired to increase the capacity beyond this, the cistern may be made deeper by the introduction of a 3-ft. vertical panel above the 6-ft. panel used on smaller sizes, so that a cistern 8′ in diameter and 8′ 3″ high to the springing line will have a capacity of about 100 bbls. Thus, it is seen that a single equipment capable of building a cistern of 100 bbls. capacity may be use for building almost any desired size from 40 bbls. up.

A Portable Derrick for Installation on Motor Trucks

A unique hand-operated derrick for handling loads up to ¾ ton is shown in the accompanying illustration, being constructed of malleable iron and steel with roller bearings where necessary. It is designed to be attached to motor trucks, although it may be used otherwise, and is tested to 1,900 lbs. in the shop.

HAND OPERATED DERRICK MOUNTED ON MOTOR TRUCK

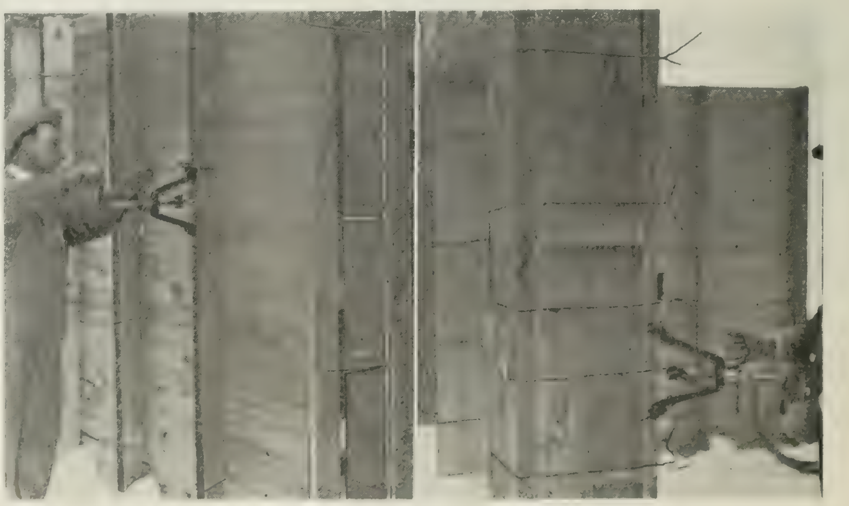
The derrick is in two parts, a "base" weighing 100 lbs. and a "beam" weighing 128 lbs. The base section consists of a steel post ribbed inside for strength and having a truck collar. It is mounted on a channel steel right angle base braced to the post as shown, clearing any obstruction that the seat will. The beam, which has a reach of 3′ 4″ and height to the block of 5′, carries the drum and has a ring which drops over the head of the post and also has two rings which straddle the post and carry rollers which ride on the truck collar. The drum carries 300′ of ¼-in. steel cable, and is operated by hand cranks. The beam has a full circle swing. There are no adjustments or attachments to remove in order to take the beam from the post on the base section.

The derrick is mounted on the truck by simply bolting the bars to the truck frame or flooring. It is made by the Taylor Portable Steel Derrick Co., 1036 West Lake St., Chicago.

A Device for Wiring Wood Forms

Concrete contractors who have encountered the old problem of how to use wood forms with the least loss of time, labor and lumber, will be interested in a device made by the Milwaukee Device Co., 1287 National Ave., Milwaukee, and shown in the accompanying illustration.

The purpose of this device is to facilitate the assembling and fixing of wood centering by use of common wire. The use of this tool obviates the necessity of transporting form-holding devices from one job to another and makes the defacement of lumber by spiking entirely unnecessary. All the wiring is done out-



THE MILWAUKEE STAY WIRE TIGHTENER AND TWISTER side the forms. This will appeal to the man who has tried to wire column or girder forms in place by manipulating a pair of 12-in. pliers in a 13-in. form. Forms are released by simply cutting the restraining wires.

This device can be operated by an inexperienced man, and after a little practice, it enables him to secure from one wire to three wires per min. It is made of malleable iron and brass, and the wire-gripping parts are made of the best tool steel. It weighs only 10 lbs. and is easily handled around on the job. It is very durable, and will stand any amount of rough handling. With ordinary care it should last indefinitely.

A 3-Cu. Ft. Batch Mixer

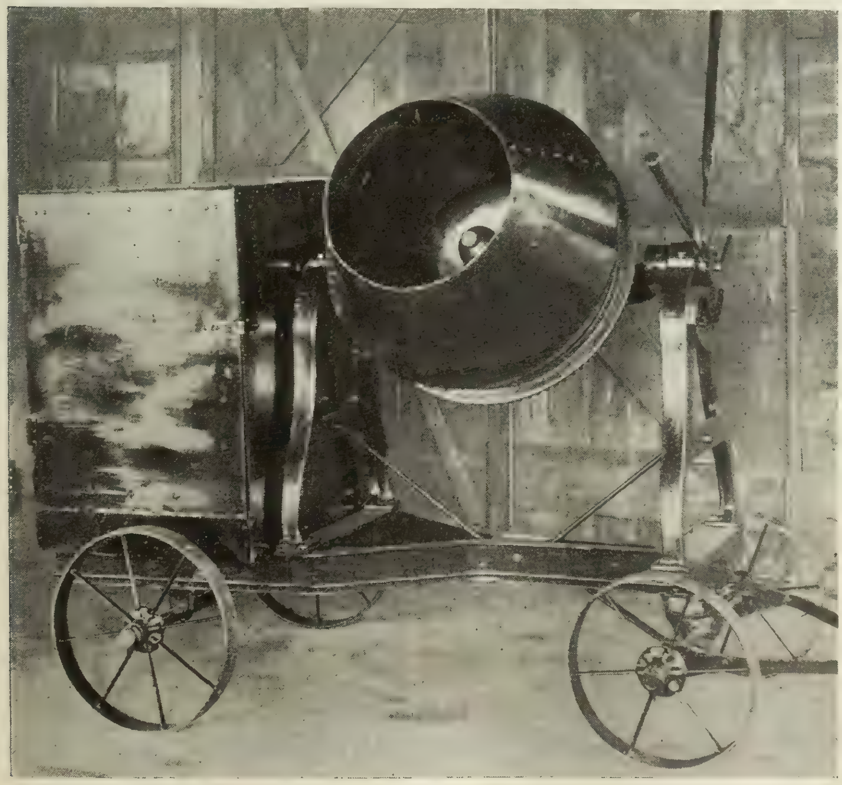
The Iowa batch mixer shown in the accompanying illustration is made by the Iowa Foundry & Mfg. Co., Fort Dodge, Ia.

The drum has a cast iron cup-shaped bowl, thus leaving no sharp angles or corners for the materials to collect in and clog the machine. The special form of yoke gives the mixer a perfect balance, which adds considerably to the ease of tilting in order to dump the mixture. The sheet steel drum is firmly riveted onto the bowl. The cast iron legs are well braced and amply strong to carry their load.

The mixer is mounted either on skids or on trucks or on trucks with engine, as shown in the illustration.

The mixing machine is fitted with two sets of roller bearings, so protected that sand or cement cannot get into the rollers, thus reducing fraction to a minimum.

The mixer has a capacity of 3 cu. ft. per batch and is claimed to mix a batch in 1 min. when operated by power, turning out from 35 cu. yds. to 50 cu. yds. per da.



The Iowa Batch Mixer of 3 Cu. Ft. Capacity Mounted on Trucks with Engine

Cinders, when used as aggregate in concrete, should be of good, clean, crushed, vitrified clinkers, as the ordinary cinders are unsuitable for such purposes. Cinders from anthracite coal are usually the best, owing to being harder, generally more dense and less liable to contain injurious amounts of sulphur.

Current Prices — Concrete Materials

Portland Cement—The prices in the Eastern cement are considerably lower than those noted last month. In the south and west, however, the quotations and the demand are about the same. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, $1.66; New York, $1.42; Chicago, $1.45; Pittsburgh, $1.40; New Orleans, $1.64 on dock; Memphis, $1.64; Cleveland, $1.53; Detroit, $1.49; Indianapolis, $1.58; Peoria, $1.49; Columbus, $1.58; Cincinnati, $1.59; Toledo, $1.53; St. Louis, $1.45; Milwaukee, $1.50; Minneapolis and St. Paul, $1.60; Duluth, $1.73; Kansas City, $1.43; Cedar Rapids, $1.50; Omaha, $1.43; Spokane, $1.75; Seattle, $2.30; Portland, Ore., $2.30; Tacoma, $2.30.

Crushed Stone—1½-in. stone, prices per cu. yd., f. o. b. cars in carload lots, unless otherwise specified. Boston, 80 cts. per ton at the quarry; New York, 90 cts. to $1.00, in full cargo lots at the docks; Chicago, $1.15; Spokane, $1.00; Portland, Ore., $1.15; Seattle, $1.50.

Gravel—Prices given are per cu. yd. f. o. b. cars in carload lots unless otherwise noted. Boston, 75 cts.; New York, 90 cts., in full cargo lots at docks; Chicago, $1.15; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.

Sand—Prices are per cu. yd., f. o. b. cars in carload lots unless otherwise indicated. New York, 50 cts., full cargo lots at docks; Chicago, $1.15; Spokane, 75 cts.; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.

Reinforcing Bars—Prices are about the same as those quoted last month. Pittsburgh base quotations on mill shipments f. o. b. cars, are from $1.10 to $1.15 per cwt., with the prevailing extras on bars under ¾″ or base. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $1.26; Philadelphia, $1.25; Chicago, $1.28; Spokane, $2.20; Portland, Ore., $1.90; Seattle, $1.85; Tacoma, $1.85.

Shipments from stock are being made at the following prices per cwt. f. o. b. cars; Pittsburgh, $1.60; New York, $1.85; Cleveland, $1.80; St. Louis, $1.80; Chicago, $1.55; Spokane, $2.50; Portland, Ore., $2.15; Tacoma, $2.20; Seattle, $2.20.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16	cts.
New York	16	“
Philadelphia	15	“
Baltimore	14½	“
Boston	18	“
Buffalo	11	“
Norfolk	20	“
Cleveland	10	“
Birmingham	45	“
Columbus	12	“
Cincinnati	15	“
Louisville	18	“
Chicago	18	“
Richmond	20	“
Denver	84½	“
St. Louis	22½	“
New Orleans	30	“
Minneapolis	32	“
Kansas City	42½	“
Indianapolis	17	“
Omaha	42½	“

Concrete Roads In Milwaukee County, Wis.

(Continued from page 74)

period.

JOINTS

It was found that there was more or less chipping in the concrete at the joints in all the old roads. This chipping, while small in many cases, warned the commissioner to treat each and every joint with a small amount of hot tar. The necessity for this treatment tended to bring a doubt into our minds of the necessity for steel plates and as a result, two miles of roads were constructed without any protection plates and this will be watched with considerable interest over winter.

The spacing of the joints was increased to 50′ in 1914 work. While an occasional crack appears, it is not believed that they are detrimental as they are transverse and the writer sees no reason for reducing the spacing of the joints and if any change is made it will be made in a still longer spacing. With the exception of one road which was built along a car track where a ditch could not be constructed, the concrete roads in Milwaukee Co. are fairly free from longitudinal cracks. It is believed that this is due very largely to a thorough destruction of the old road, thus giving a uniform sub-grade for the concrete. It is also partly due to the construction of the grade some distance ahead and the building of fairly good ditches.

EXPERIMENTS.

In the last two seasons various experiments have been carried on by this department as regards the surface treatment of concrete roads. Several different combinations of asphalt and tars have been used and at some future date our opinions of the various processes will be given out.

One piece of road was constructed in 1914 with some of a so-called hardener compound incorporated in it.

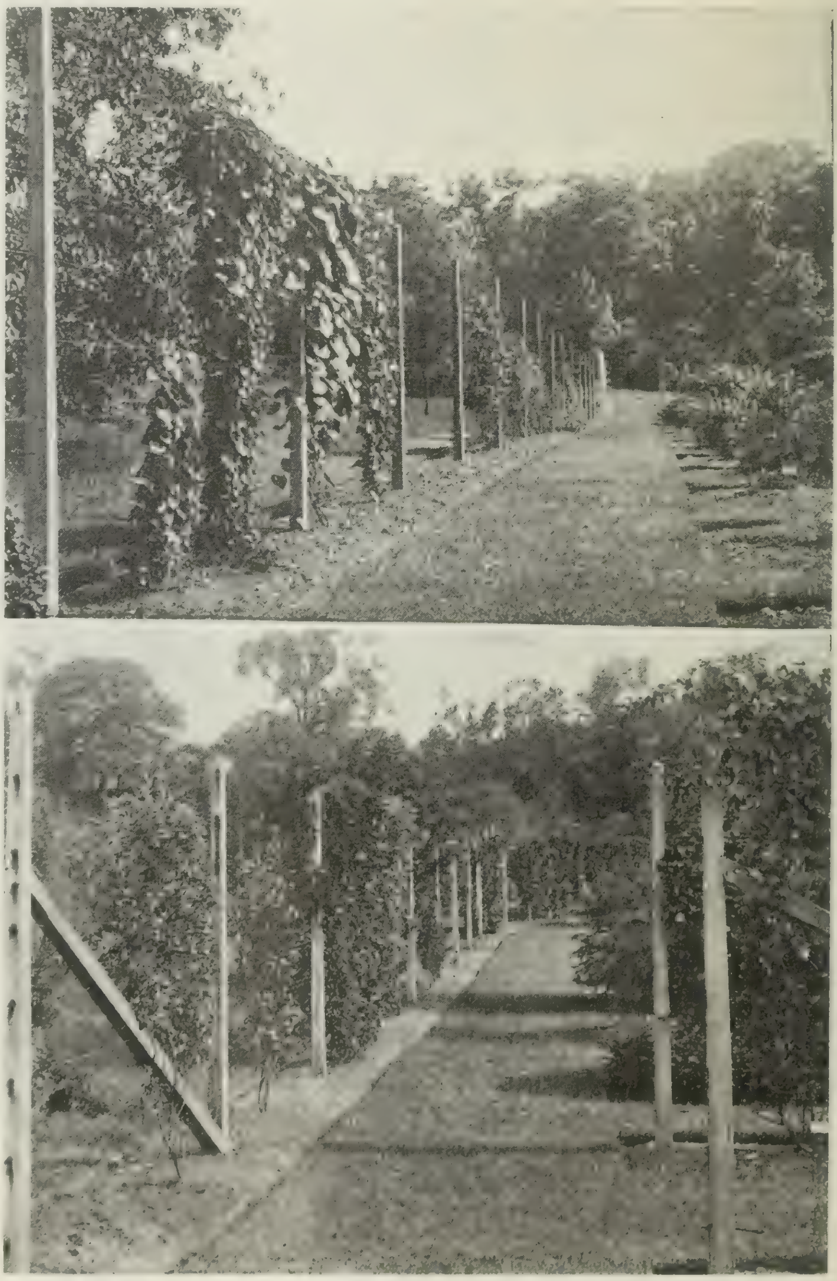
CONCLUSION

As stated in the beginning of this article, there are disadvantages as well as advantages in concrete roads but we feel that we have selected the best type for the conditions and the expenditures being made and to be made are as economical as can be expected with any form of road that can be built to withstand modern traffic conditions.

Concrete Posts Used in Arnold Arboretum, Boston

The accompanying illustrations show the use of reinforced concrete posts in the Arnold Arboretum, Boston. The posts are slender, considering their height of 8′, being only 5″ x 5″ at the base, tapering to 3″ x 3″ at the top. They were made by workmen at odd times and many of them have been in use for five yrs. The wires which support rare vines are spaced 1′ apart and are threaded through holes in the posts, made by the insertion of small rods when the posts were cast. The end posts, as shown, have holes for large eyebolts, held by nuts, and the wires, which are fastened in the eyes, are tightened by turning up the nuts. This trellis is durable and pleasing in appearance and the vines, many of them very rare, have good light and do not have to be disturbed for repairs to the trellis.

Concrete should not be too wet or too dry. If too wet it will shrink an excessive amount in setting and hardening; if too dry when placed it will not be dense, as the mortar will not run into the spaces. It is better to use too much than too little water, but mixtures that are too wet are not so strong as medium mixtures.



Trellis of Slender Concrete Posts Strung with Wires at Arnold Arboretum, Boston

The vines are of many kinds some rare species. Some of them in the illustration are grapes and wistarias

Concrete-
Cement Age

Vol. 6 *Detroit, March, 1915* *No. 3*

Just Aggregate—Not "Fine" Nor "Coarse"

WHY has practice in concrete work clung so tenaciously in the matter of aggregates to an idea that "fine aggregate" is one thing and "coarse aggregate" a distinctly different thing? Time was when it was not fully recognized that grading is the all-important thing, but proper grading removes any arbitrary distinction between coarse and fine. The real answer to the question is undoubtedly in the "condition of the market." William M. Kinney pointed out at the convention of the American Concrete Institute that this is a situation with which the industry must wrestle. In substance his contention is that the engineer and contractor must demand exactly the grading of materials required for their work. Specifications have repeatedly been drawn for concrete materials based upon the condition of the market—that is, upon the sizes of stone and gravel usually carried in stock. As long as the material man can give the concrete man the same stone he gives the railroad for ballast or the highway contractor for macadam roads he is going to do it. But as soon as the concrete industry demands a graded material suited to its peculiar needs it will get it.

Carry this to its logical conclusion, then, and "fine aggregate" and "coarse aggregate" must disappear and leave graded aggregate in their place. The progressive concrete stone manufacturers who operate their own crushers recognize no such thing as fine and coarse aggregate. They crush their stone, separate it into various bins and re-combine it. If rhetoric afforded more degrees of comparison, good practice in the matter of aggregate might be described, but "fine," "finer" and "finest" are inadequate. Why any arbitrary divisions at all? It is all aggregate and should all be graded. The maximum size will be fixed by the size of the work, by the way the mixture must be manipulated and by the surface finish desired; the minimum size will be determined in great measure by the peculiar quality sought; resistance to surface abrasion, as in floors, or great density and impermeability. Yet between the stated maximum and minimum sizes the material should be graded, and in time that is the way it must be supplied. It remains for the engineer to specify.

The Chicago Cement Show and Its Field of Influence

UNDOUBTEDLY the most convincing evidence of the success of the Cement Show in the Chicago Coliseum, Feb. 10-17, was in the demand for space at next year's Show. The exhibitors know whether or not a show is a success—from their standpoint. And their judgment is evident in the fact that within a few hours after the beginning of the allotment of space for the 1916 Show, every inch in the main building and most of that in the annex had been taken. There is strong reason to believe that the Show management will arrange for additional exhibition area in adjoining or nearby buildings.

It was undoubtedly the best Show ever held, from the standpoint also of the visiting contractor who was looking for equipment. It was a machinery show. Never has another such array been seen of machinery of the concrete field. Never have so many different mixers been seen at one place; never has there been such a showing of small mixers—everybody seemed to have produced a small mixer. By "small" mixers is not meant "cheap" mixers. The last two or three years have witnessed an ever-increasing popularity of the small batch mixer—a machine that will hold and mix material that will measure five good cubic feet in its mixed state. The increased demand for these mixers has been of a two-fold nature. The small contractor who used to mix by hand has learned the economy and accuracy of machine-mixing. The large contractor has learned the economy of letting a small mixer start the big job and, later, finish it, thus obviating the necessity of keeping his big mixing plant on the work from first to last. He has also learned something of the flexibility of mixing equipment composed of two or three small units. The Cement Show reflected these influences, for there was hardly a single manufacturer of heavy mixing machinery who did not show a mixer with a capacity as low as five feet, mixed material.

The fact that continuous mixers of good engineering design and reliable construction occupy a particular place all their own was shown by the several machines of this type on exhibition brought nearer perfection by small mechanical improvements. The continuous mixer is coming into a stronger position in the field than it once occupied.

Another group of exhibits marking a notable step in the progress of the industry included bag-bundlers and machinery for handling bulk cement—equipment affecting two phases of the contractor's cost problems, from different angles.

It has not been so very long since there was no such thing as a machine for bundling empty cement bags. The bag nuisance grew to such proportions and was so annoying to cement manufacturers and users alike that an extensive campaign was started to show contractors the proper methods of handling, storing and returning "empties." This educational work convinced the cement user of the good, common sense of taking proper care of empty cement sacks and at this Show he found simple machines of varying design for counting, tying and tagging bundles of empty bags.

The buyer of Portland cement who wished to rid himself of the bag nuisance completely was shown simple, inexpensive equipment for unloading and storing cement if he chose to have it shipped to him in bulk.

The visitor saw fewer hand-operated block machines and more power tampers.

He saw a great deal of equipment for building silos—monolithic and unit construction. The business of building silos is rapidly taking an important place in this industry. When we hear that one contracting firm down in Indiana erected 80 silos last season, the importance of this young branch of concrete construction becomes very apparent. At the show the farm owner found plenty of reason for deciding upon the safety of a concrete silo investment.

The wonderful advance of concrete road construction made its impress upon the Show. For the first time, metal side forms for roads and pavements were made important features of steel form exhibits. Again the mixer men were in evidence, with special types of portable mixing plants used in laying roads and pavements. Exhibitors interested in highway construction reported an unusually high percentage of city engineers, highway officials and road builders among the visitors.

On every hand the engineer and the contractor saw progress. It was a show for the man who does the constructing—for the man with an intimate knowledge of the uses of equipment. He could translate what he saw into terms of a bigger concrete industry—more work, better done. It was a good show for the buyer of equipment.

A Cement Products Show Without the Products

ANY opinion as to the success, the fruitfulness of the Cement Show must, of course, be based upon an understanding of what its purpose is. The object certainly is not to make money for the stockholders in the Cement Products Exhibition Co. The very name of the organization implies an intention to create interest in the products of cement, that is, in concrete; to further the use of cement in concrete work through exhibits showing the possibilities of the resulting material.

The recent Chicago Show suggests a question as to whether or not the Cement Show has not evolved into a market place—the general characteristics of which are such as to show concrete contractors the machinery with which to carry on their work in the most efficient way—a market place for equipment rather than an exposition of *cement products* — products which should be of such character as to influence architects and owners to use these products and thereby create new business for the contractors. It may be that the industry needs the market place more than it needs the exposition. It should not be lost sight of, however, that the Cement Products Exhibition Co., through its Cement Show, has two functions: To show to the practical constructor the newest developments in the machinery and tools with which he can work to best advantage, and to show the architect, the public who is the consumer, and to the builder, actual examples of concrete. The public can scarcely be expected to specify concrete for its new houses because of any favorable influence in viewing a mixer in which the raw materials are manipulated. Neither is the architect convinced of the architectural qualities of concrete by an admittedly valuable machine for bundling empty cement bags. Nor does a great array of machines and tools and accessories give even to the builder himself a vivid picture of the finished excellence of the concrete itself—the end for which he must strive.

The Exhibition company management can take the stand that it offers the spaces for sale and beyond exercising a censorship for the elimination of improper exhibition features, leaves it to the buyers of space to exhibit what they please. The Show rightly belongs to the exhibitors. It is for them to give it its character. This year's Show, however—essentially a machinery show—prompts the suggestion that the show management should go further in its efforts to give the desirable character to the exhibition. The machinery is essential; its wonderful development marks the progress of the industry. Mixers are a prime necessity; bag bundlers are a boon to the cement user—money in his pocket by providing a systematic means of avoiding profit-eating losses; and how could concrete work be done without systems of forms? All the machines and tools should be seen at the Cement Show; they are, in themselves, a highly educational feature. But where is the boasted concrete? Where is the material which demonstrates the purpose and the effect of all this display of accessories? The answer is: Chiefly in unrelated though handsome and otherwise creditable examples in the booths of individual cement companies. There is no big dominant characteristic display of the manifold applications of concrete, as there undoubtedly should be. Such displays have been left to individual exhibitors, some of whom have done very well, but the result is not a co-ordinated effort such as could possibly be expected to convey to the visiting public the tremendous object lesson which the public expects.

For a Better Show

CRITICISM that the Cement Show was too much a machinery show does not carry the suggestion that less machinery should be shown. It does carry the suggestion that the show should contain many more examples of the ultimate product of all the machines—more concrete. This would not, by any means, weaken the appeal of the equipment; it would strengthen that appeal by providing tangible evidence to answer the question: "What is it all about?" Each individual exhibitor naturally devotes his space to the thing he has to sell. It seems desirable that the Exhibition company itself should undertake to present the samples of concrete work and make those samples the dominant feature of the Show. The thing which the public should carry away from the Show is not a din in its ears—although the din must remain—but a vivified impression of the realities of concrete.

The management lacking, for next year, the central space in which to make an impressive and convincing exhibit of concrete, might foster some co-operative arrangement among the exhibiting cement companies and other exhibitors whose work at the show is chiefly along general educational lines, to carry out some definite and co-ordinated scheme for a comprehensive exposition of concrete in most of its uses.

Eleventh Annual Convention of the American Concrete Institute

The American Concrete Institute held its 11th annual convention at the Auditorium Hotel, Chicago, Feb. 9 to 12, with a registered attendance of about 350 and an average attendance at meetings of about 100. Richard L. Humphrey, who had rounded out 10 yrs. as the president of the Institute, originally organized as the Natl. Assn. of Cement Users, was succeeded by Leonard C. Wason, president of the Aberthaw Construction Co., Boston. Other officers elected are: vice-presidents, W. K. Hatt and H. C. Turner; treasurer, Robert W. Lesley; directors, W. H. Ham, Ernest Ashton, A. E. Lindau and W. P. Anderson. Charles L. Fish has been appointed secretary to succeed Edward E. Krauss. A motion by Mr. Lesley was adopted to the effect that the incoming directors, in the absence of necessary provision in by-laws, take suitable action to make Mr. Humphrey honorary president in recognition of his long service to the organization.

As a result of liberal donations from individuals who feel that the Institute is of sufficient importance to them, in developing and standardizing concrete work, to justify financial support, the Institute comes into the possession of about $17,000, which will enable it to meet all its obligations, complete the publication of its *Proceedings* and take care of other work in the immediate future. Annual membership dues have been increased from $5.00 to $10.00. Announcement has been made through the *Journal* of the Institute that President Wason will present a medal annually to the member contributing the best paper.

ANNUAL ADDRESS OF PRESIDENT

President Richard L. Humphrey in his annual address reviewed the growth in the use of concrete in the last decade and the part which the American Concrete Institute has played in that growth. He mentioned that in this time the organization has had presented at its conventions 236 papers and 56 committee reports and that the *Proceedings*, published in 10 volumes make 5,858 pages. In closing he paid a tribute to his successor in the presidency, Leonard C. Wason, as a devoted supporter of the work of the Institute.

The opening session of the convention was held on the morning of Feb. 9. The opening address of welcome was made by Warren C. McGann, Commissioner of Public Works, Chicago. He presented the compliments of Mayor Harrison.

Papers, Reports and Discussions on Concrete Roads

PRESENT PRACTICE IN CONCRETE ROAD CONSTRUCTION

Percy H. Wilson,[1] presented under the title: "Review of Present Practice in Concrete Road Construction," a summary of present practice and sketched the increase in the amount of concrete paving work, which he said in 1914 was about 15,000,000 sq. yds. in the U. S., or more than in all previous years combined. He recommended further investigation of suitable aggregates, indicated an absence of necessity for the use of metal protection plates at joints and suggested more thorough curing methods.

THE SERVICE TEST CONCRETE ROAD IN PHILADELPHIA

A paper by William H. Connell,[2] "The Service Test Concrete Road in Philadelphia," was read by Mr. Fish. This described the methods which are being used in the construction of what is known as the Oxford Pike Service Test Concrete Roadway. The entire work is to extend over a length of a little more than two mi. Each section of concrete will have a length of 2,250′, divided in two sub-sections. The object of the work, which was undertaken after consultation with the Assn. of Am. Portland Cement Mfrs., is to construct a concrete road to give good service where the traffic comes directly on the concrete and "to try out certain types of bituminous surfaces on the different characters of concrete construction, embodied in the various sections of this roadway, with a view to finding some such material as could be aplied with a thickness of not over 1/4″, that would adhere to the concrete and not peel off, as has been the case with practically all of these film coat bituminous surface treatments." The work was begun Oct. 4, 1914.

REINFORCING NARROW CONCRETE ROADS

John Mueller[3] presented a paper on "Reinforcing Narrow Concrete Roads," in which he reviewed some of the reports and discussions of the National Conference on Concrete Road Building. He pointed out that while engineers generally agreed upon the advisability of reinforcing concrete roads when wider than 20′, he proposed to go further in urging that narrow roads also be reinforced. He enumerated the causes of cracks in concrete roads as follows: 1, uncertain foundations; 2, changes in moisture content; 3, changes during setting period; 4, temperature changes; 5, thickness of pavement; 6, length of slab; 7, irregular surface of sub-grade. He proposes practically to eliminate cracking by the use of reinforcing. He believes the slab should be reinforced near the top but that there should be further reinforcement near the bottom of the slab whenever the foundation is uncertain and the drainage not well cared for. He said that suitable reinforcement could be provided for from 6 cts. to 8 cts. per sq. yd.

REPORT OF COMMITTEE ON CONCRETE ROADS

In the absence of A. N. Johnson,[4] chairman of the Committee on Concrete Roads, the report was presented by W. M. Kinney,[5] who read the suggested changes in the printed proposed specifications[6] of the Institute and these will be submitted to letter ballot of the members.

CONCRETE ROADS AND FROST ACTION

Andrew M. Lovis[7] presented a paper, "Concrete Roads and Frost Action," in which he emphasized the importance of sub-grade preparation, putting particular emphasis on drainage.

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[1] Secy., Assn. Am. Portland Cement Mfrs.

[2] Chf., Bur. of Highways and Street Cleaning, Philadelphia

[3] Civ. Engr., New Castle, Ind.

[4] Bur. of Municipal Research, N. Y. C.

[5] Engr. in Charge, Insp. and Inf. Bur., Universal Portland Cement Co., Chicago

[6] *Journal*, Am. Concrete Inst., Vol. III, No. 1, p. 15, Jan., 1915

[7] 1st Asst. Engr., Mass. Highway Com., Boston

COST OF CONSTRUCTION AND MAINTENANCE OF CONCRETE ROADS

A paper by H. J. Kuelling[8] on "Cost of construction and Maintenance of Concrete Roads" is in abstract as follows:

After the quality and the thickness of concrete to be built have been determined there are naturally many local conditions that will have a marked bearing on the results; such as lengths and kind of roads available to haul material over, facilities for unloading and hauling aggregates and cement; amount of labor available; the necessity for camps; the distance and elevation that water must be carried and also its source; the availability of suitable aggregates, whether they must be washed, or crushed or shipped by rail; the weather conditions that are liable to exist. Any or several of these conditions may have a marked effect on the cost of construction. Given answers to these questions or conditions, the problem of figuring the cost becomes much simplified.

Assuming the standard Wisconsin State specification which calls for a 1:2:3½ mix and assuming a pavement with an average thickness of 7", I will attempt to show you how we arrive at our estimates of costs. Some of the statements may seem like the A. B. C. of engineering, but will perhaps be of assistance to laymen.

With an average thickness of 7" we allow only five sq. yds. per cu. yd. of concrete, allowing the extra inch as a factor of safety.

With a 1:2:3½ mix we know we need approximately ½ cu. yd. of sand and about 0.84 cu. yds. of aggregate or a total in all of about 1⅓ cu. yds. of material for one cu. yd. of concrete. No suitable material is available without shipping in by rail and we find that washed sand and gravel can be laid down at almost any siding in the country for $1.00 per cu. yd. of sand or gravel, the sand to weigh 3,000 lbs. per cu. yd. and the aggregate a little less, depending upon the idea of the dealer.

This brings our sand and gravel for one cu. yd. of concrete to about $1.33 or about 27 cts. per sq. yd. of road.

The next problem encountered is unloading this material onto the hauling vehicle. In our case nearly all has been done by hand. Allowing for lost time due to rain, switching of cars and waiting for teams and figuring at from $2.25 to $2.50 per da. of 10 hrs., we have a cost of 5 cts. per sq. yd. for unloading. This may be reduced a little, but we have found it safer not to expect too much from shovelers, especially in hot weather.

The next item is the most variable of any, perhaps in the entire cost, that of hauling. The length of haul, the method of hauling and the kind of roads to haul over, all have a marked bearing on the results; here also possible weather conditions must be taken into account, for after a rain the size of load and number of trips must be materially reduced. Where steep grades are encountered, extra teams must be figured upon. Assuming an average haul of 2½ mi., a team would average about 3½ trips per da. under our conditions or about 17 mi. per 10-hr. da. in the various kinds of weather, it costs $6.00 per da., which we often are forced to pay, and assuming an average of 1¾ cu. yds. per load we arrive at a cost of $1.35 per cu. yd. of concrete or 27 cts. per. sq. yd. of road.

The mixing and placing, under which we include all labor connected with the job such as watchmen, pumpmen, smoothing grade, etc., will, with our labor conditions and allowing for lost time and overhead expenses, come to about $1.00 per cu. yd. or 20 cts. per sq. yd.

In case steel joints are placed these will come to about 2½ cts. for the steel and ½ ct. for the felt when placed 50' apart and ¼" in thickness of felt.

The cost of furnishing water is rather uncertain for the amount of pipe necessary may vary from one mi. to three mi. or even more mi. per job. Assuming two mi. of pipe at a rental of 2 cts. per foot for use in placing a road one mi. long we have a water cost of about 2 cts. per cu. yd.

For carrying liability insurance a contractor must add about 1½ cts. in our state.

The depreciation on machinery we have found to be about 1¼ cts. per sq. yd.

Trimming up the shoulders will require an additional expenditure of about 1 ct.

The items as enumerated bring us to a total of 87¾ cts., to which we add a reasonable profit when figuring what a contractor should bid.

Since we furnish cement in all cases we add our cement cost only after the profit percentage has been included. With cement at $1.14 per bbl. on cars and 20 cts. per bbl. for cartage, we arrive at a cost of about $2.25 per cu. yd. of concrete for cement or 45 cts. per sq. yd.

This gives us a total of $1.32 without a contractor's profit, under the conditions we met in 1913. Work done in 1913 by force account varied from $1.30 to $1.61 and that done by contract varied from $1.24 to $1.72, the variations depending entirely upon the local conditions.

In 1914 with cement slightly higher but with labor and terms considerably cheaper, but other conditions about as in 1913, the costs in Milwaukee Co. varied from $1.10 to $1.45.

An engineer should thus be able to compute the cost of the various items in his community and separate the labor and material into fairly definite percentages for each job. He will find that cement will vary the least, while hauling labor will vary the most.

In conclusion on the question of cost of construction, I want to repeat that it is merely a guess unless all local conditions are considered.

Maintenance—The question of maintenance is one that will vary with the quality of concrete in the road. In other words, concrete that is of uniform texture will wear in a manner similar to sandstone blocks and therefore demand very little maintenance whether the aggregate be of hard or of fairly soft material; the harder and tougher the sand and stone, the longer the life of the pavement. Where the mortar and the aggregate are allowed to become separated when the concrete is being placed, there is certain to be an uneven wearing of the surface which naturally becomes more and more pronounced as the traffic pounds, in falling into or climbing out of the depression.

It would, therefore, seem that the first maintenance required in a concrete road is to get as uniform and tough an aggregate as possible and then to be sure that the concrete is properly mixed and placed. In case small depressions do occur the time to look after them is as soon as they appear. We believe the best method to be about as follows:

The surface should be first swept with a steel broom to loosen any dirt; after this the spot should be thoroughly swept with fiber street brooms to remove the fine dust which the steel brooms leave behind; we use ordinary house brooms which leave the surface in a fairly clean condition.

The depression is then covered with hot Tarvia X and covered with coarse sand or screenings and opened to traffic. In case the depression is of considerable depth, or what might be called a hole, I would advise one of two methods. First (in case it is desired to avoid delaying traffic) clean the depression as already described, and then paint it with a tar, upon which bring the whole to grade with crushed stone, being careful not to have stone as large in size as the depth of the depression. Tamp the stone in place with hand tampers or roll with a roller, if one is available, and fill the voids with a heavy bituminous road binder, allowing about one gal. per sq. yd. per in. in depth. The second method is to cut the poor place out entirely and after trimming the hole and thoroughly sprinkling the sides, fill with the same mixture as was used in the original road. After pouring the concrete, treat the same as in reconstruction.

Small defects, due to balls of clay, sticks or coal getting into the aggregate, may be best repaired the same as described for shallow depressions. The same is true of the battered joints or cracks that may appear.

We consider it economy to have a small maintenance crew go once or twice each year over all the roads in the county. Such a crew consists of a foreman, 1 team and 4 laborers. This crew will, under average conditions in Milwaukee Co., cover all the joints, cracks and small pits in from one mi. to two mi. of 18-ft. road in one da. at a cost of from $15.00 to $30.00 per mi. for labor and material.

When it is deemed advisable to cover the entire surface, the same method of cleaning may be followed excepting that most of the dirt may be removed with a power sweeper and the tar applied with a power sprayer. After the first treatment of ¼ gal. to ⅓ gal. of tar has been applied, a second may be added in the same manner excepting that an asphalt may be substituted for the tar as it will adhere to the tar already placed where it will not to the concrete. We have several pieces treated in different manners as to materials used and we are looking forward with interest to see in what condition they appear this spring.

Treatment of concrete roads as a whole, whether necessitated by poor workmanship, defective materials, or freezing, is considered a rather expensive process compared with spending more in the original cost and getting a road of a quality that will not require such a coating for many years. Even if a treatment will last for two seasons, which is very doubtful under conditions of heavy mixed traffic, the cost will come to several hundred dollars per mi. per yr. Of course such a coating has some advantages such as acting as a cushion to horses, preventing wear on the concrete itself, doing away with glare and being applied without delaying traffic. On the other hand it makes the road more slippery and a little less clean. The writer believes that the time is not far distant when a coating of concrete 1″ or more in thickness will be applied to a poorly built concrete road and made to stay there, thus giving an entirely new wearing surface.

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[8] Highway Commr., Milwaukee Co., Wis.

In conclusion we believe that maintenance varies inversely as the quality and uniformity of the concrete in the road, not arithmetically but more nearly geometrically, due to the uniform wearing of a uniform concrete.

COST OF CONCRETE ROADS

A paper by Percy H. Wilson on "Comparative Cost of Concrete Roads" reviewed data collected by the Assn. of Am. Portland Cement Mfrs. from all parts of the U. S.

Reinforced Concrete—Design and Construction

CONCRETE UNDER MICROSCOPE

Nathan C. Johnson[9] contributed interesting food for thought in an address which discussed the nature of concrete as revealed by examination under a microscope. The address was illustrated by numerous lantern views from micro-photographs. Mr. Johnson said he had no special theory to advance except as to the importance which he believes attaches to a better knowledge of concretes—a knowledge which starts from an examination of the material itself with the aid of a microscope to show its structure. He especially dwelt upon the fact that practically all concretes reveal a surprisingly large quantity of unhydrated cement, apparently due to the difficulty in diffusing the water in the mix, and that the importance of grading and mixing is shown by the voids which the microscope reveals.

TEST OF A CONCRETE SLAB

Because of the uncertainty existing among bridge designers and concrete engineers regarding the distribution throughout a concrete slab of the effects of loads, the U. S. Office of Public Roads, about three years ago, undertook a series of experiments to determine, if possible, the effective width of reinforced concrete slab under various conditions of loading. The results of this investigation are given in a paper "Test of a Reinforced Concrete Slab,"[10] by E. B. McCormick.[11]

Some interesting results were obtained at first with slabs 7′ x 9′, using a span of 6′, but it soon became apparent that the size of the slab must be increased if definite, corroborative results were to be secured. As a consequence, a slab was made in the summer of 1914, measuring 12″ thick by 32′ wide and with a span of 16′, and designed for a fiber stress of 659 lbs. per sq. in. along the top surface. The reinforcement consisted of ¾-in. sq. bars, spaced 7¼″ o. c. Cylinders 8″ x 16″ cast from the same mix showed a modulus of elasticity of 2,900,000 at an age of 6 wks.

Nov. 16, 1914, this slab was tested to destruction with a total load of 119,000 lbs. applied by means of a 150-ton hydraulic jack at the center on a plate 12″ x 24″, the width of slab over which failure extended being about 17′.

The work will be continued until a sufficient number of slabs has been tested to warrant the deduction of definite laws relating to the distribution of stresses in loaded concrete slabs. There is now under construction a thinner slab of the same area, per cent. of reinforcement (0.75) and proportions of materials. The tests on this slab will include measurements to determine fiber stresses on the bottom of the slab and also the slippage of the reinforcement, and, if possible, what effect the thickness of the slab has on the effective width.

THE DESIGN OF CONCRETE BRIDGES WITH SPECIAL REFERENCE TO STANDARDIZATION

The object of a paper by C. B. McCullough[12] on "The Design of Concrete Bridges and Special Reference to Standardization" is to discuss in relative order of time and importance, stream behavior and its effect on design, the question of loadings, the calculation of stresses and the working out of details as applied to highway bridges.

In treating the question of bridge design, according to Mr. McCullough, a study of stream conditions logically asumes first place in point of time and may be so placed in order of importance, particularly if the construction is of concrete, inasmuch as this material when once misplaced can be corrected only at a tremendous expenditure. Certain conditions affecting the selection of the type of bridge, such as available materials, headroom, accessibility of concrete, etc., are largely local and must be worked out for each individual structure, but their relationship to stream development and topography is extremely important in fixing the type chosen for standard construction for small work over any considerable area. The necessity for a study of stream erosion as a part of each bridge survey cannot be too strongly emphasized.

Next in the order of time and importance comes the question of dead loads and live loads, and the amount and effect of internal temperature variations. The total load distribution may be considered as composed of two portions; that due to the strength of the section itself and that due to the fill or covering material.

The determination of the internal temperature range in concrete was, during the years 1908 to 1912, made the subject of a series of experiments by the Iowa State College Engrg. Exp. Sta. and the Iowa State Highway Comm. Based on the results of these experiments the following conclusions were stated:

1. The yearly range in temperature in a reinforced concrete arch, typical of the highway arch construction in Iowa is, in this latitude, not far from 80° F.
2. The relation between the depth of concrete covering at any point and the yearly temperature range varies from about 90° F. at the 6″ from the exposed surface to 70° F. at 3′ 4″ from the same surface.

The results of the foregoing investigation lead to stress values many times in excess of those which have heretofore been assumed to result from temperature variation and have considerably modified the shape and size of the concrete highway arch as adopted in Iowa.

In the design of concrete arches, it has been customary among many designers and engineers to allow an arbitrary percentage of from 10% to 20% of the dead load and the live load stresses to cover stresses induced by temperature change. All stress values then become a function of the external loading and, according to Mr. McCullough, the following relationships can be easily shown to exist:

1. For a given span the moments are independent of the rise but the thrusts vary inversely as the rise.
2. The fiber stress being largely determined by the bending moment rather than the thrust does not increase rapidly with a decrease in rise and analyses of very flat arches often fail to indicate serious overstress.
3. The unit fiber stresses vary approximately as the bending moment and inversely as the square of the depth of section. Thus a condition of overstress can be remedied by simply increasing the section, as the moments and thrusts remain practically unchanged.

In view of the fact that the temperature variation, particularly for light highway loadings, becomes the determining factor. the following relationships which can easily be proven seem to have an important bearing on the limitation of the design:

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[9] Engr. Tests, Raymond Concrete Pile Co., N. Y. C.

[10] *Journal*, Am. Concrete Inst., Vol. III, No. 2, p. 57, Jan., 1915

[11] Mech. Engr., Ofc. of Pub. Roads, U. S. Dept. of Agri., Washington

[12] Design. Engr., Ia. Highway Comm., Ames, Ia.

1. For a given span the moment due to temperature varies inversely as the rise and the corresponding thrust varies inversely as the second power of the same. Thus a slight decrease in rise will produce a material increase in ring stress.

2. While the fiber stresses for a given moment vary inversely as the square of the depth of section it must be remembered that in dealing with temperature changes the moments themselves vary directly as the cube of the depth of section. Thus when the temperaturee moment constitutes the largest part of the total moment an increase in section ofttimes operates to increase rather than decrease the unit fiber stresses.

3. The stresses due to temperature are maximum at the crown and spring line of the arch but of opposite sign. These decrease from crown to spring line passing through a zero value and assume their original or crown values at a point near the quarter (this point can be determined exactly for every arch, it being dependent upon the shape and size of the arch ring).

From the first two considerations it is at once apparent that for each span length there will be a limiting minimum rise beyond which it is not safe to design. From the third consideration it is apparent that for light highway loadings in which temperature stresses are largely governing there need be in general but slight increase in section between the crown and the quarter point.

REINFORCED CONCRETE HIGHWAY BRIDGES AND CULVERTS

It was deemed desirable by the Committee[13] on Reinforced Concrete Highway Bridges and Culverts to cover certain points in specifications for reinforced concrete highway bridges and culverts by definite specifications, but certain other points must be varied according to the special circumstances of the case and, therefore, what is considered to be the best engineering practice is stated and recommended for adoption by the public.

Specifications and recommendations were submitted, not as final, nor even as voicing the unanimous opinion of the members of the Committee, but merely as preliminary suggestions, in the hope of bringing out the discussion of doubtful points and information regarding questions which the Committee could not answer.

REINFORCED CONCRETE AND BUILDING LAWS

The Committee on Reinforced Concrete and Building Laws presented the results of tests[14] of 24 reinforced concrete columns of large size having a variety of reinforcement, both longitudinal and lateral. In the tests, measurements were made to find the deformation in various parts of the column, including the stretch in the spiral rinforcement. This set of tests is a part of a program laid out by the Committee for the purpose of determining the influences of both spiral reinforcement and longitudinal reinforcement upon the structural properties of columns.

The results of these tests warrant the following conclusions:

1. They seem to confirm the current practice as to the effect of varying percentages of longitudinal reinforcement within the range of these tests as expressed in the following formula:

$$f = fc\ (1-p) + nfc\ p$$

where $f =$ average unit load over the whole column section
$fc =$ compressive unit stress in concrete
$p =$ ratio of the area of longitudinal reinforcement to the area of the column section
$n =$ ratio of the modulus of elasticity of steel to the modulus of elasticity of concrete

2. They indicate that columns with spiral reinforcement are stronger and tougher than columns with no spiral reinforcement.

3. For these tests it would appear that the spiral reinforcement is approximately four times as effective in giving ultimate strength to the column as the same volume of longitudinal reinforcement.

4. It appears that the effect of the longitudinal reinforcement decreases as the percentage of spiral reinforcement increases.

REINFORCED CONCRETE STANDS, STADIA AND BOWLS

In a paper by Chas. W. Leavitt[15] on "Reinforced Concrete Stands, Stadia and Bowls" it is stated that about the year 72 A. D., Vespasian built the Colosseum at Rome of stone, brick and concrete, decorated with marble. The structure still stands as an object lesson worthy of exhaustive study, not only for its decorative beauty, but also for its system of underground chambers, dens, drains and general construction. In spite of the fact that about two-thirds of the building material of the Colosseum was carried off in the Middle Ages and used elsewhere, it is still a wonderful lesson in durability.

The concrete stand, stadium or "bowl," reinforced with steel, presents today in a great many cases, according to Mr. Leavitt, the best solution of the problems of economy, stability and durability. It is usually cheaper than all-steel, is not so liable to decay, is more stable than steel and involves a minimum cost of maintenance.

The stadium at Lehigh Univ., South Bethlehem, Pa., designed by the author of this paper, is of reinforced concrete, and when completed will enclose a field 200′ x 600′ entirely on two sides and partly on two others, leaving one corner open. The entire athletic field is arranged on two terraces, with a drop of 33′ between them. The upper plateau contains the practice-field, running tracks, buildings and parking space; the lower plateau contains the stadium, including the gridiron and the baseball diamond.

The old grass-stepped banks from which many of the English sports have been witnessed were the source of the idea of the bowl, and reinforced concrete seems to be the best medium for future development of this idea. The problem now is to make a suitable foundation that will permit a minimum amount of concrete to be used.

DESIGN AND CONSTRUCTION OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY BUILDINGS

Sanford E. Thompson[16] spoke from notes on the construction of a large group of buildings for the Mass. Inst. of Tech. His talk was illustrated by lantern views. This work will be covered in detail in a paper by Mr. Thompson to be completed later and embodied in the *Proceedings* of the Institute.

THE MANUFACTURE AND LAYING OF CONCRETE SEWER PIPE

A paper by Henry T. Shelley[17] on "The Manufacture and Laying of Concrete Sewer Pipe," will be presented in full in this magazine.

TESTE OF CIRCULAR AND EGG-SHAPED REINFORCED CONCRETE SEWER PIPE

In a paper by Alfred T. Goldbeck[18] on "Tests of Circular and Egg-Shaped Reinforced Concrete Sewer Pipe" are given the results of a series of tests on concrete pipe for sewers, which had not previously been used in Philadelphia. The circular pipe was 36″ in diameter and 4″ thick; the egg-shaped pipe was 36″ high and 24″ wide, 3⅛″ thick, with a flat base 8″ wide. The aggregates were N. J. bank sand and well graded ¾-in. crusher-run trap rock. Some pipes with slag aggregate were also tested, the slag weighing 74.7 lbs. per cu. ft., when shaken to refusal in a cu. ft. measure. The concrete was machine-mixed in the approximate proportions of 1:2:3½. The pipes were reinforced with triangular mesh. Both air- and steam-cured pipes were tested. The pipes were required to sustain an imposed load of 1,000 lbs. per sq. in. before the first hair-crack showed.

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[13] Chmn., Willis Whited, Bridge Engr., State Highway Dept., Harrisburg, Pa. Report published *Journal*, Am. Concrete Institute, Vol. III, No. 2, p. 117, Feb., 1915

[14] *Journal*, Am. Concrete Inst., Vol. III, No. 2. p. 47, Feb., 1915

[15] Civ. & Landscape Engr., N. Y. C.

[16] Consult. Engr., Newton Highlands, Mass.

[17] Asst. Engr., in Charge of Sewer Construction, Philadelphia

[18] Engr. of Tests, Bur. of Surv. Philadelphia

The following conclusions are stated in the paper:

1. Reinforced concrete pipes, when properly made and properly cured, are very satisfactory for the construction of sewers.
2. The use of a concrete cradle greatly increases the stiffness of the pipe and raises the load under which initial cracking takes place.
3. For sections of the size tested and for smaller sections, the placing of the reinforcing near the inner face throughout the entire circumference seems to be justified.
4. The matter of curing should be very carefully controlled, as much stronger pipes will result if care is taken to keep them thoroughly wet, preferably for a period of two wks.

A CRITICAL REVIEW OF CURRENT PRACTICE IN REINFORCED CONCRETE

The object of a paper[19] by Edward Godfrey,[20] "A Critical Review of Current Practice in Reinforced Concrete as Embodied in Building Regulations and the Joint Committee Report," on the above subject is to criticise very severely some of the modern theories on reinforced concrete design, the author stating that practically all of the reinforced concrete failures have been due to faulty design and generally the design is standard, accepted by the profession.

Mr. Godfrey states that the Report of the Joint Committee on Concrete and Reinforced Concrete[21] is the main subject for criticism in his paper, not because there is nothing to commend in the Report, but because the faults are so glaring and have bred so many wrecks that the Report ought to be revised at once. He emphasizes the fact that the recommendations permitting the use of plain concrete or rodded concrete columns were wrong and states that the only safe way to design a column is to use a spiral or hoops and upright rods. He also criticises the same Report for recognizing stirrups or shear members in beam design.

Mr. Godfrey also questions in his paper the stability and strength of flat slabs designed according to the recent Chicago Flat-Slab Ordinance.[22]

BASIS OF CURRENT PRACTICE IN DESIGN OF REINFORCED CONCRETE STRUCTURES

C. A. P. Turner,[23] in a paper on the "Basis of Current Practice in the Design of Reinforced Concrete Structures," illustrated by stereopticon slides, states that the universally accepted basis of reinforced concrete design may be summarized in the following stock quotation from such building codes as the Chicago, San Francisco and Columbus codes, and those of other cities:

"The adhesion is such as to cause concrete and steel to act together"—or "The bond between the concrete and the steel is such that the two materials shall act as a homogeneous solid."

Adhesion or bond is thus generally accepted as the connecting link between the concrete and the metal, and we should naturally expect to see its operation discussed in all the literature of the art found in textbooks and the like, but such discussion is almost entirely lacking.

This paper criticises the report of the Joint Committee on Concrete and Reinforced Concrete for permitting the use of plain or rodded concrete columns and urges that the design of columns well hooped and vertically reinforced be encouraged. It also criticises the Design of Reinforced Concrete Flat Slabs, according to the new Chicago Building Ordinance, stating that it allows in a light rectangular slab a thickness so small that the true concrete stresses may under test be at least 50% higher than would be computed.

Mr. Turner further states that the variation in the regulation of different cities amounts to more than 100% in the amount of material required in the construction of columns for the same load. Such a variation cannot evidently be based on any rational hypothesis.

Mr. Turner also takes issue in his paper with the critics of flat slab design and argues that it is not only safe but a perfectly logical design, going at some length into the mathematical and the empirical formulas used in this design. He states that about 50% of the building codes in the U. S. require 50% more steel than necessary.

The papers by Mr. Godfrey and Mr. Turner resulted in heated and prolonged discussion, holding the session until 1 o'clock in the morning.

A NEW-OLD THEORY FOR REINFORCED CONCRETE BEAMS IN BENDING

In a paper[24] by L. J. Mensch[25] on "A New-Old Theory for Reinforced Concrete Beams in Bending" it is stated that some of the modern theories for reinforced concrete design are not practical and that they do not give to the designer any means of knowing what factor of safety his constructions have, and that they prevent a sound development of the art of reinforced concrete construction. Mr. Mensch bases his arguments upon the facts that:

(1) A plane section before bending is greatly distorted after bending.

(2) The ratio of the moduli of elasticity between steel and concrete was not the same after cracks appeared in the number.

(3) In every report on tension failures of tests of reinforced concrete beams, we find that the approaching failure was marked by vertical cracks gradually increasing in width and height, diminishing the compression zone, but only rarely the proper conclusion is added that the beam really failed finally by compression in the concrete and at a stress in the reinforcement which is somewhat a mean of the elastic limit and the ultimate strength. The author proposes to show that the formulas derived from the equilibrium conditions at the moment of failure are very simple and agree exceedingly well with tests made both here and abroad.

Concrete Products, Stucco, Floors, Architecture

REPORT OF COMMITTEE ON CEMENT PRODUCTS

C. K. Arp,[26] chairman, presented the report of the Committee on Cement Products, in proposed revised Recommended Practice for Concrete Architectural Stone, Building Block and Brick and for Plain Concrete Pipe and Drain Tile and new Proposed Recommended Practice for Concrete Fence Posts.[27] These will be submitted for adoption by letter ballot.

CEMENT ROOFING TILE

A paper by J. S. Freund[28] gave an account of the development of concrete roof units, particularly as used on large commercial buildings. This paper will be presented in a later issue of this magaine.

SOME PRINCIPLES OF DESIGN AS APPLIED TO CONCRETE HOUSES

Charles E. White, Jr.,[29] was not present to read his paper, "Some

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[19] *Journal*, Am. Concrete Inst., Vol. II, No. 7, p. 10, Dec., 1914

[20] Struct. Engr., Robert W. Hunt & Co., Pittsburgh

[21] *Proceedings*, Am. Soc. C. E., Vol. 39, pp. 117-168, Feb., 1913

[22] CONCRETE-CEMENT AGE, Nov., 1914, pp. 194-6

[23] Cons. Engr., Minneapolis

[24] *Journal*, Am. Concrete Inst., Vol. II, No. 7, p. 28, Dec., 1914

[25] Cont. Engr., Chicago

[26] Universal Portland Cement Co., Chicago

[27] *Journal*, Am. Concrete Inst., Vol. III, No. 1, p. 64, Jan., 1915

[28] Gen. Mgr., Am. Cement Tile Mfg. Co., Pittsburgh

[29] Architect, Chicago

Principles of Design as Applied to Concrete Houses," and it was read by title only and will be published in the *Journal* of the Institute.

REPORT OF COMMITTEE ON TREATMENT OF CONCRETE SURFACES

As the report of the Committee on Treatment of Concrete Surfaces, Leonard C. Wason, chmn., presented Proposed Standard Specifications for Portland Cement Stucco on Wood Lath[30] and an amendment as to top finish[30] to the standard specifications for concrete sidewalks, plain concrete floors and reinforced concrete floors as follows:

Fine aggregate shall consist of a crushed stone which tests or experience have proved to withstand abrasion well. The stone in any locality that is most satisfactory for macadam roads is suitable. It shall be graded from fine to coarse, the larger particles predominating in quantity, and passing, when dry, a screen having ½-in. round holes, and preferably none shall pass a screen having 30-meshes per lin. in.

This paragraph is to be inserted as follows:

Standard No. 2. Standard Specifications for Portland Cement Sidewalks. Insert in place of paragraph (*a*); retain second paragraph of 2 (*a*).

Standard No. 13. Standard Specifications for Plain Concrete Floors. Insert in place of paragraph 2 (*b*).

Standard No. 14. Standard Specifications for Reinforced Concrete Floors. Insert in place paragraph 2 (*b*).

A NEW AND SIMPLE METHOD FOR SECURING DUSTLESS CONCRETE FLOORS

A paper by P. M. Bruner,[31] "A New and Simple Method for Securing Dustless Concrete Floors," and the discussion of this subject, led by Leonard C. Wason, which follows, were features of the convention. Mr. Bruner's paper is as follows:

Portland cement concrete sidewalks, having a top coat richer in cement than the concrete of the body of the blocks, are giving such general satisfaction that this paving has displaced those of almost all other materials. Even for driveways and roadways, concrete is beginning to compete with other favored materials, and with good prospects of superseding all other materials where the traffic is not excessive. Under these circumstances it has been a puzzle to find out why the wearing surface or top coat on reinforced concrete floors inside of buildings has given such scant satisfaction. The same composition for top coating, giving satisfaction in the basement, often is worthless when applied to the reinforced concrete on the upper floors. In the last few years technical papers have been full of complaints and suggestions on this point. Under special and unusual conditions, good floors have *occasionally* been laid of reinforced concrete in the ordinary way. For this and other reasons most experiments seeking to overcome the trouble have also been successful at times, and yet more often have been failures, thus leaving the faultiness uncorrected and the cause hidden more completely by misdirection.

And here perhaps is the place to define faulty, or so-called "dusty" floors. All floors are dusty that wear at all, and in cities all floors are dusty whether they wear or do not wear; but in this latter case all of the dust comes from sources other than the floor itself. The dusty floor that confronts and concerns the concrete worker is one in which the fine sand or other aggregate ravels out or rolls out of its bedding under moderate rubbing, scratching, or rolling of wheels. This produces, incidentally, both the objectionable dust and grit.

Such continuous failures have naturally created a demand for correctives to be applied after the failure has occurred, or for hardeners to be added to the original composition to assist the cementing potency of the Portland cement sufficiently to avoid the failure. One corrective of a floor that is faulty is the subsequent painting with ordinary paint, or with paint that has more or less varnish in it. These paints serve in part as a wearing cover, and in part as an agglutinating agent between the grains of sand. They also prevent water from reaching the interior of the top coat thereafter which otherwise might penetrate and aid in the hardening process in the course of time. Another corrective of a floor that is denominated "dusty" has found advocates. In this process the floor is rubbed or ground with a piece of grindstone, fastened to a handle, and assisted by some loose sand scattered over the surface of the floor. This work is so performed that the soft cement between the grains of sand on the upper surface of the floor is rubbed out without disturbing the grains of sand in their bedding. When almost the whole of the upper halves of these grains of sand is exposed the rubbing is discontinued and the spaces around the grains of sand are filled with neat cement which is ground in with the same rubbing instrument. This process may form a strong filling around the grains of sand, as also a very thin covering over the top of the grains of sand. This is good as far as it goes, and will enable a job to pass inspection that would not pass before. It adds, however, no strength to the weakened cement immediately below the middle of the grains of sand. On this account the trouble may return after the floor has had some service. Instead of remedying the faults of a finished floor, efforts have also been made to increase the cementing potency by adding so-called hardeners to the Portland cements. The active ingredients of most of these hardeners are, chiefly, fine pulverized iron and sal-ammoniac which are suposed to make between the grains of sand the old and well known rust-joint, in conjuction with the Portland cement. The work done by us with these hardeners, under the instructions of their official specifications, and under the advice of their superintendents, has failed to justify the claims made for the hardeners. Tests made for us by the Robert W. Hunt Co., with and without hardeners, did not show any advantage for them. Under unusual conditions, as said before, good work has sometimes been done by the ordinary routine work, hence one may surmise that these hardeners have given satisfaction and have been credited with benefits due to other causes than their own inherent value.

According to my observations and experiments, I came to the conclusion that cement top coating on reinforced concrete remains weak and deficient in strength because of the excess of water that is required to make the mortar plastic enough to be properly spread and struck off with a straightedge. This excess of water has no chance of escape downward, and rises toward the surface, where it remains until the setting process of the cement has well advanced. When a certain portion of the water has become bound in this way, in the setting process, the mortar stiffens up and becomes ready for the usual process of finishing and smoothing. Sometimes the setting goes forward too rapidly, so that the finishing cannot be carried out without sprinkling some water over the top to enable the workmen to work out a smooth finish. It follows that the floor is finally finished only after a period of 4 hrs. to 12 hrs. after the composition was first made into a plastic mortar. Not only is the strength of such a floor injured by the excess of water bound and entangled in the pores of the mass, but also by the disturbance of the crystallization process.

The only feasible way to overcome the difficulties then seems to be that to withdraw the excess of water that was necessary for the spreading and the rodding of this plastic mass to the desired level or grade of the finished floor. To bring this about, therefore, I lay on the plastic floor surface, when brought to its proper level, a webbing of some kind, and place over this some dry material which quickly withdraws the excess of water by the capillary attraction of the dry materials. This may take up 20% to 30% of the water originally used in producing plasticity of the mortar. It will not take up more than this, however much dry material is applied, and the amount of water left in the mass corresponds quite well with the amount that a professional cement-tester considers necessary in making proper test pieces.

My surprise in my first experiment, in regard to the condition of the top coating after the cloth was lifted off with its load of damp material, was great. It had become so hard or stiff, in 20 min. after the dry material had been placed over it, that one could walk over the surface without making even a heel mark. In fact, the coating was so dry and stiff that it required a powerful effort to float it with a wooden float to an even finish that could be smoothed off with a trowel. This effort, however, forced the grains of sand so much closer together that in this way some moisture was forced upward from within the more compressed mass, so that the floor could be properly smoothed off. The time between the spreading of the mortar and the smoothing of the floor need not be more than 30 min. Without the use of this drying process, we have, as said before, found that it would require the expiration of from 4 hrs. to 12 hrs. before the work could be successfully brought to this stage.

What I claim for this process is: First, a harder and a denser top coat; second, a wearing coat that is equal to the best work on sidewalks; and third, the elimination of overtime work by an extra expenditure for labor of only 1/10 ct. to 1/5 ct. per sq. ft. in laying a floor, and this extra expense is more than offset by the usual cost of overtime work. I do not claim to improve the cement, but I simply get out of it all the strength there is in it. If any hardener can be found that will increase the wear-resisting quality of Portland cement concrete, this process of mine will still be a profitable one, inasmuch as it increases the density of the resulting cement topping, and the work proceeds without delay and without the need of overtime work. The process is even more desirable where the wearing coat is placed on the reinforced concrete soon after this has been poured. In this case there is still less chance to get rid of the excess of water downward, for the foundation itself in this case is saturated clear through the mass with the water used in making the concrete itself liquid.

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[30] *Journal*, Am. Concrete Inst., Vol. III, No. 1, p. 82, Jan., 1915

[31] P. M. Bruner Granitoid Co., St. Louis

It is perhaps also well to point out that the top coat placed over reinforced concrete should not be made too heavy. There is considerable difference in the expansion and the contraction of the two materials under standard specifications. A medium thickness of top coat will therefore more readily adjust itself to the reinforced concrete beneath. A heavy top coat, on the other hand, may assert itself sufficiently to bring about a powerful shearing strain between the two, so that they will separate at the expense of the weaker mass. Specifications should not call for more than a ½″ thickness, nor allow a maximum of more than 1″. A top coat of ½″ thickness on sidewalks, subject to the heaviest traffic, will last more than 25 yrs. The top coat should not be made to correct irregularities of the surface on which it is placed. Those who lay the so-called sanitary or magnesian cement floors will not undertake to lay a greater thickness than ⅜″ to ½″ thickness because this material expands still more than any Portland cement concrete. Because Portland cement topping demonstrates this fact less clearly, it is generally applied in thicknesses up to 1½″ and 2″. The reinforced concrete contractor can, if he will, obtain a levelness that will require no extravagant thickness of topping. He can also construct this floor so that there will be no laitance on it. This laitance is a soft, chalk-like mass that has not sufficient strength to hold the topping, or even to hold to the concrete beneath, itself.

In the course of the discussion which followed, Mr. Bruner explained in greater detail has patented method of removing excess moisture from topcoat work. A floor is ordinarily finished in strips. As soon as the top coat has been applied, a strip of burlap is thrown over it and pulled out evenly over the surface by workmen at each end. Dry sand is then thrown on this burlap from shovels, entirely covering the surface in a thin layer. After about 20 min. the burlap is pulled up and lifted off with the sand, when the surface is in the condition for finishing described in the paper.

In further discussion of floor and sidewalk top finish Mr. Wason emphasized the importance of the new amendment which his committee submitted for the standard specifications, in urging that experience has shown that fine sand and cement will not produce surfaces with high resistance to abrasion.

Emile Perrot[32] reported that in an effort to economize in the construction of a school building the floors were finished, using slag aggregate. He said that the result were remarkably satisfactory, the floors having worn so as to take what is almost a polish, being hard and dustless.

In reference to floor hardeners Mr. Wason said that his company had tried many of those offered on the market but had come to the conclusion that boiled linseed oil, applied to a dusty floor, gives the best result, with silicate of soda solution (waterglass) as a second choice. He had used both with satisfaction. Boiled linseed in one thorough application had stopped dusting, he said, in one building in particular, and there had been no recurrence of the trouble in several years' wear.

Cloyd M. Chapman[33] said that in experiments with numerous patent materials to find a satisfactory floor hardener or dusting preventative, two or three preparations of an oily nature had given the most satisfaction. He used linseed oil, raw instead of boiled, as recommended by Mr. Wason.

It was suggested that inasmuch as linseed oil leaves a floor with a rather mottled appearance, a small amount of lampblack added to the oil will give a better looking floor. The mottled appearance left by oil alone is due to the fact that a floor is seldom equally dense over its entire surface and uneven absorption of the oil gives an uneven color. Questions were asked as to the quantity of oil required, and Mr. Wason and Mr. Chapman said that 1 gal. would cover from 75 sq. ft. to 100 sq. ft. The oil is flowed on in generous quantity and the floor permitted to absorb all that it will take up.

Mr. Wason emphasized the importance of careful curing. He suggested a means for keeping a floor during the period of curing at a constant condition of dampness rather than wetting it down at intervals and permitting it to dry out before wetting again. He pointed out that alternate wetting and drying causes surface strains through expansion and contraction due to the varying moisture content and must therefore result in weakening the surface.

Ralph L. Shainwald, Jr.,[34] suggested other means for avoiding excess moisture in finishing a floor. He said that it had proved satisfactory to put in the base unusually dry and to tamp it thoroughly and then apply a top coat as soon as possible as wet as is ordinarily necessary to finish properly, when the excess moisture instead of coming to the top would be taken up by the drier base.

SYNTHETIC STONE IN CATSKILL AQUEDUCT BUILDINGS

H. Lincoln Rogers[35] presented a paper, read in the absence of the author by Mr. Fish, on the "Synthetic Stone in Catskill Aqueduct Buildings." This is presented in full elsewhere in this issue, together with numerous illustrations of manufactured stone in addition to those presented with Mr. Rogers' paper.

CONCRETE: A MEDIUM OF AESTHETIC EXPRESSION

Irving K. Pond[36] presented a paper, "Concrete: A Medium of Aesthetic Expression," in which he expressed regret at the lack of progress in the years which had elapsed since Nov., 1907, when as chairman of a then existing Committtee on applied arts and sciences of the American Institute of Architects he had reported on the possibility of concrete in the field of architectural expression. He said that much of his paper had been written at that time and that most of his statements, unfortunately, still applied. "The science (of reinforced concrete design) has become a bit more exact * * * but the art of design seems not to have kept pace." Further abstracts from this paper are:

> The architect is not a mechanical fabricator of mathematical diagrams. His highest concern is with the ideal, and his first sketch should present an idea, an idea which is conceived in beauty. The past has demonstrated that architecture as the expression of the ideal can materialize in but one or the other of two great manners: that of the articulated structure, unit added to unit, and that of the plastic mass. The most noble development in the first manner is in the architecture of masonry (brick or stone) and this development has reached its logical limit; in no way, except, it may be, in mere size, its least noble attribute, is it to be excelled. Under the vital art of this first manner lay an intuitive science; under the too transient beauty of the work of the second great manner lay nothing of science at all, and so this architecture has well-nigh vanished except as some adherence to the principles of the first manner has interposed to save. And now comes the ghost of what might have been and calls for a reincarnation, feeling (if a ghost can feel) that in reinforced concrete science is preparing a body which can be vivified with the spirit of art. If this feeling is substantiated, to the architect is opened up a new range of possibilities. The architect becomes in a sense a sculptor, a molder of monumental mass, not the fantastic figure, who, at first, with sharply insistent blows, and then with infinite persuasive tappings, releases the form imprisoned in the block, but a creative constructor who builds up his ideal

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[32] Archt., Ballinger & Perrot, Philadelphia

[33] Engr. Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

[34] Standard Paint Co., N. Y. C.

[35] Archt., Bd. of Water Supply, N. Y. C.

[36] Archt., Chicago

and shapes it by the irresistible, though tender, molding of mass and form.

The possibilities, even the aesthetic possibilities, within the range of reinforced concrete construction can hardly be overestimated. Little beyond the introductory chapter has been written in the history of reinforced concrete, and every advance in the science of its manufacture and use will signal an advance along the line of artistic application.

Except in well defined types, designed to serve certain well defined uses, it is impracticable so to carry masonry construction beyond and behind the facade as to result in a homogeneous structure—wanting which architecture becomes but a hollow sound. The architecture of a reinforced plastic material may, and logically will, express itself throughout the entire structure to the remotest core. The unity, the truth, the harmony of the whole may in every part be manifested. Therefore, again, the possibilities inherent in concrete present themselves alluringly to the architect to whom the art means as much as does the science of building.

The architectural brain is not so congested by the weight of pregnant thought that at a blow a Minerva shall issue forth full-fledged and full-armed. That is not the history of the evolution of an architectural style. It will take time and struggle, and developed artistic perceptions in this, as in former cases, to reveal the possibilities of beautiful and of monumental design.

It may well be conceived that a molded architecture, so to speak, an architecture of flowing and harmoniously interrelated masses, may not appeal immediately to the architect who has been taught that his art consists in naively piling up child's building-blocks on a large scale. Whatever may be urged against the deadly dulling practice of following the line of least resistance in architecture, certain it is that a material in which it is easier, as well as more logical, to fashion new and appropriate forms than to follow cut and dried conventions can not be regarded as other than a vivifying factor in a possible architectural development, and its advent hailed with delight. When architects relieve themselves of the notion that monumental architecture, for example, consists solely in a row of classical columns superimposed upon a basement, it will be a wholesome day for the art they profess to practice. Probably ignorance, inability and self-distrust in the architectural ranks will remove to some more or less remote future the development of a monumental architecture expressing itself in new forms fashioned in new materials. Yet it is possible that, in this, as in other ages, commercialism, itself so devoid of aesthetic tendencies, will pave the way to the realization of an aesthetic ideal. A material which holds in itself the qualifications for commercial use will in that very use reveal its aesthetic possibilities. No material which puts into the hand of the architect power to produce permanent mass and form, and add the enrichment of light and shade, color and texture, will long be ignored when science has made its use commercially possible.

But to-day, with art and science cooperating, it would seem as though architecture were on the verge of an awakening. Commercial architecture with us is beginning to feel the thrill. Abroad monumental architecture as well is showing signs of a renewed joy in life, and structural concrete, both of itself and embellished with richer materials, furnishes the new and seemingly adequate medium of architectural expression.

Much of this was written, as I said in opening, some years ago. Reviewing the events of the years that have passed, it does not seem that there has been such an advance in the aesthetic field as opportunity seems to have offered, or as might have been expected. But we cannot lay this backwardness altogether to the manipulator of concrete nor to the architect. Economics may be a factor.

CONCRETE IN METROPOLITAN CONSTRUCTION

Charles E. Fox[37] made a most interesting address on "Concrete in Metropolitan Construction," in which he told why, more particularly in skyscraper construction, reinforced concrete is not taking the place of steel frame. He pointed out that many large metropolitan structures are erected upon leased sites and that it is common for leases to go into considerable detail as to the type of structure which shall be erected. The owners of such land are not influenced in favor of materials and methods of construction which are cheap, but are interested in seeing buildings which will be permanent and secure. Such owners have not been favorably impressed with the advocacy of concrete for its cheapness, which was at one time so common. Mr. Fox said that the fruit of the talk of cheapness has in many cases been aversion to concrete rather than its adoption. Where a lease specifies so much in detail as to the character of the building, it is not within the power of the architect or even of the lessee to call for concrete if either of them choses to do so. The speaker said that the objections of owners to concrete will cease when engineers and contractors can positively assure concrete construction as absolutely secure, dependable and scientific. Besides speaking of these conditions affecting the owner of the leased property, Mr. Fox dwelt at some length upon the speed with which all-steel frame buildings can be erected. The new Morrison hotel, Chicago, was cited. This, one of the tallest buildings in Chicago, extending 55′ below ground, was begun Jan. 1, 1914, and completed Dec. 15, 1914. Mr. Fox explained the advantage of steel in the fact that work on the frame may proceed as soon as caissons are completed and that excavation proceeds while the steel frame goes up, construction actually progressing upward and downward at the same time. Other advantages of steel frame are in the fact that a steel frame structure is almost entirely shop-fabricated and site-assembled; the frame provides support for temporary floors and staging and scaffolds on which the work of numerous trades proceeds in proper order at various floor levels. Column size is another important item cited in favor of steel for skyscrapers.

REPORT OF COMMITTEE ON EDISON FIRE AND DISCUSSIONS

The Edison Fire Committee,[38] after a careful investigation of the character of the buildings and their contents, the origin and intensity of the fire and the behavior of the various materials of construction in the fire, reached the following preliminary findings[39]:

1. No building or any portion thereof can be considered absolutely fireproof. The resistance of buildings and building materials to fire is relative only; no material can resist a fire if it be of sufficiently great intensity or long duration.

2. The information obtained confirms the general principles already well established concerning protection against the origin and spread of fire.

3. The buildings of this plant were not in accord with present well established practice in that they deviated from this practice in the following particulars:

(*a*) Large, undivided floor areas. (Lack of fire walls and stops.)

(*b*) Unprotected exterior openings. (Wooden sash with plain glass, etc.)

(*c*) Absence of proper fire walls, partitions and fire doors.

(*d*) Failure properly to inclose vertical openings, stairways and elevator shafts.

(*e*) Absence of adequate sprinkler equipment.

(*f*) Absence of adequate water supply and fire-fighting apparatus.

(*g*) Failure either to isolate non-fireproof buildings or to protect against them.

(*h*) Failure to isolate hazardous processes of manufacture either by placing such processes in separate buildings or by surrounding them with proper fire walls.

4. The fire fully demonstrated the advantages of monolithic structures. The fact that at five different places several of the wall columns were rendered useless and yet the upper portions of the building stood intact is evidence of the superior merits of concrete in monolithic construction.

5. Considering the extraordinary conditions surrounding this fire, the behavior of the concrete buildings was highly satisfactory and constitutes an excellent demonstration of the merits of concrete as a fire-resisting building material. It is not so surprising that the concrete buildings were damaged as that any material should have so satisfactorily withstood these unusual conditions.

6. This fire brought out the following important problems which are considered worthy of further investigation:

(*a*) The strength of the structure after the fire; to be determined by floor load tests.

(*b*) The extent to which the floor system has been strengthened by the method of reconstruction.

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[37] Marshall and Fox, Archts., Chicago

[38] Chmn., Cass Gilbert, Archt., N. Y. C.

[39] Full Preliminary Report, *Journal*, Am. Concrete Inst., Vol. III, No. 2, p. 79, Feb., 1915

(*c*) The strength of the columns after the fire; the strength of the restored columns.

(*d*) The effect of expansion, from temperature changes, on large units.

(*e*) Such other effects of this fire on the structures and structural materials as the conditions may permit.

7. The Committee is of the opinion:

(*a*) That the best type of construction is one which eliminates corners and presents flat or rounded surfaces to the action of the fire. That interior columns of circular or octagonal section offer greater resistance to fire and are less liable to damage than columns of square section, and that the elimination of sharp corners in the floor construction is desirable.

(*b*) That good construction requires a sufficient number of lateral ties or hooping in the columns, and that such construction would offer greater resistance to fire.

(*c*) That in the beam and girder type of construction in order fully to develop T-action the slab should be cast at the same time that the beams and girders are poured, and there should be adequate ties between the reinforcement of the beams and girders and that of the slab.

The detailed information upon which the foregoing statements are based is submitted with the report.

A series of investigations and tests is being arranged to develop additional data which, it is expected, will require some time and which will be presented in a final report as soon as the data can be obtained and collated.

Following the report of the Committee on the Edison Fire, which was outlined by Secretary Moore, and illustrated by many lantern views showing not only the progress of the fire but the condition of various structures after the fire, there were interesting comments by Rudolph J. Wig[40] on the fact that the heat was so intense in some portions of the fire-swept buildings as to slag the concrete. Nathan C. Johnson made interesting comments on the microscopic examination which he made of concrete from the burned buildings.

President Humphrey, in discussing the remarks by Messrs. Wig and Johnson, called attention to the fact that the so-called slagging of concrete occurred in one building where the extraordinary material used in the process of manufacture caused a sloughing away of the concrete and of all other structural materials with which it came in contact; that, in general, there was no slagging of the concrete but where some foreign material had slagged on the surface of the concrete it gave the appearance of slagging.

Regarding the heat penetration into the concrete discussed by Mr. Johnson, he stated that immediately after the fire the concrete generally was very hard and did not show evidences of calcination nor did the dehydration extend into the mass of the concrete. He was of the opinion that samples of concrete which Mr. Johnson took from the columns after they had been stripped two or three inches preparatory to repairing could not possibly have shown damage from heat since in general the heat action extended only a very short distance.

T. L. Condron[41] described and illustrated by lantern views some of the repair work on the Edison buildings. Square columns, spalled at the four corners, were chipped down to circular section, wrapped with metal mesh, enclosed with circular steel forms and filled in with very wet cement-sand mixture, through holes drilled in the floor above. Surfaces were of course carefully cleaned before this work was undertaken. Beams and girders of enlarged section were repaired in a similar way. In most cases additional reinforcing, except for mesh wrapping, was not considered necessary. Where supporting members were broken, however, where rods were exposed and in some cases deformed by heat, much more complicated measures were adopted. The repair work has progressed under difficulties owing to the urgency of resuming factory operations in some cases before repairs were completed. Mr. Condron said he would present his discussion in writing and much more in detail at a later time to be embodied in the *Proceedings*.

Field Problems in Concrete Construction

CONTRACTOR'S EQUIPMENT, AUSTIN NICHOLS WAREHOUSE

T. A. Smith,[42] in a paper on "Contractor's Equipment, Austin Nichols Warehouse," illustrated by stereopticon views, states that the economy in the successful erection of reinforced concrete buildings is dependent upon the efficiency with which the materials entering into the construction are handled upon delivery at the building site. He further states that the comparatively small yardage of concrete in any one building operation does not justify an elaborate and costly installation of receiving and mixing machinery. He believes that the installation should be figured on a basis of the cost per cu. yd. of the concrete.

Regarding the use of spouts for conveying concrete by gravity, Mr. Smith states that after the job has been figured out it was found that the cost of the spouting outfit, together with raising the tower and in addition the construction of the guying tower and moving spouts, was found to exceed the cost of doing the job by wheeling the material into place.

MECHANICAL PLANT FOR HANDLING CONCRETE

W. P. Anderson,[43] in a paper on "Mechanical Plant for Handling Concrete," states that there are two classes of equipment which can be used. One class is that which is standard and can be used on nearly every job. This class of equipment consists of mixers, hoists, charging and placing barrows and similar equipment. The second class covers that which can be used in special cases only, such as unloading devices, industrial track and cars, cableways and other special machinery.

Mr. Anderson advocates handling the aggregate directly from the cars to the mixers, without storage. Where this is done, it is well to store some of the aggregate for emergencies, and a convenient arrangement of the plant for this purpose is to build bins along the unloading switch. Where this arrangement is followed it is nearly always unavoidable to have some demurrage on cars, but it saves rehandling of material and in a number of cases this saving is greater than the extra charge incurred in demurrage. On very large jobs it might be well to build two overhead charging hoppers, one for the sand and one for the stone. In unloading material from cars where the arrangement mentioned is not practicable it is sometimes found advantageous to have a hopper which can be fastened to the side of a car and the material can be shoveled from a car directly into this hopper.

The location of the mixing plant on any job, according to Mr. Anderson, is determined by two factors: first, depending upon the ease of getting the materials of which the concrete is composed delivered near the plant; second, the position of the plant relative to distributing the concrete to all parts of the work, with as little labor as possible.

In placing the concrete, Mr. Anderson states that the most convenient form is to chute it from the main hoist to various positions of the work, and in some cases to re-elevate and re-chute where the building covers a good deal of ground. He mentioned another method of handling concrete, which is the use of large derricks and bottom-dumping buckets.

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[40] U. S. Bur. of Standards

[41] The Condron Co., Chicago

[42] Gen. Supt., Turner Const. Co., N. Y. C.

[43] Pres., Ferro.-Conc. Constr. Co., Cincinnati

CONCRETE FORMS FOR THE CATSKILL AQUEDUCT

In a paper on "Concrete Forms for the Catskill Aqueduct," Alfred D. Flinn[44] describes in considerable detail the concrete forms used for the aqueduct, under the headings: Forms for cut-and-cover aqueduct, forms for lining and jacketing steel pipes, forms for grade and pressure tunnels, shaft forms for concrete blocks, forms for gate-chambers and other special structures, forms for bridges and fence post molds. A few notes on cost, methods and progress are given. Stereopticon views were used in illustrating the paper.

STRENGTH OF CONCRETE FORMS

The object of a paper[45] by H. S. Taft[46] on the "Strength of Concrete Forms" is to show that although concrete form-work is of a very temporary nature, it is of the utmost importance that it be designed and constructed to meet the loads brought upon it by the wet concrete; otherwise disaster is likely to result to the temporary structure. While construction has become so universal, the design and building of the form-structure is being studied and looked after almost as carefully as the concrete itself.

Mr. Taft treats the design of forms in their final analysis as beams uniformly loaded. When the points of support are all on the same straight line, the beams are in the nature of continuous girders. How far they depart from being continuous girders depends upon how far the points of support depart from a straight line.

In determining the strength of the various members of a form-structure it is necessary to figure them for both deflection and strength and then use the smaller of the two values, as explained in this paper.

The nature of the pressure or load per unit upon concrete forms depends upon the type of the form. In column and wall forms a hydrostatic condition exists. In slab work a direct load has to be considered, while in beam forms a direct load as well as a hydrostatic pressure exists.

Elaborate tables and curves are given covering the design of forms as ordinarily met with in concrete construction. In heavy arch bridge work or other structures carrying a heavy load, special study of each condition is necessary in order to obtain the best results and to be sure that proper strength has been provided in the temporary wooden structure,—cases that are of such a special nature that it was impossible to cover them in the present paper.

MIXING, CURING AND PLACING CONCRETE WITH HIGH PRESSURE STEAM

A paper on "Mixing and Placing Concrete with High Pressure Steam" by Harold P. Brown,[47] states that concrete mixed and placed by means of a special concrete atomizer[48] weighs more than 170 lbs. per cu. ft., possesses from three to four times the strength of average concrete, has to a certain extent a crystalline nature and will take a high polish.

The process consists in thoroughly mixing measured amounts of cement, sand, broken stone and water in a cylinder which is then filled with a hot gas or vapor under high pressure. When the proper pressure and temperature have been reached and the curing process (said to be due to perfect hydration and effective chemical action) is completed, the outlet valve is opened and the plastic concrete is dropped into a superheated stream of rapidly moving gas or vapor. The wet particles are separated from each other and can be carried several hundred feet in a rubber-lined hose to the point of deposit, which may be many feet above the mixer. The stream is projected through an expansible nozzle and strikes the work at high speed, causing the concrete to adhere strongly to brick, stone, reinforcing steel or old concrete and at the same time obtaining a quick set. During each period of mixing a stream of super-heated steam is kept flowing at low pressure through the outlet to keep the hose and the destination of the new work warm and moist.

It is claimed that with careful handling, excellent work can be done in freezing weather.

INVESTIGATIONS OF HIGH MAGNESIUM CEMENTS

The object of a paper by P. H. Bates[49] on "Some Further Results Obtained in Investigating the Properties of Portland Cements Having a High MgO Content," is to give further data concerning high magnesium Portland cements, burned in the experimental plant of the Bur. of Standards at Pittsburgh. This paper contains the results obtained from a second series of burns, as well as later tests of the physical specimens of the first series reported at the last meeting of the Institute.[50]

The same procedure was followed in the present series as in the first, but in the present investigation the composition was changed so that the resulting cements have a lower lime-magnesia content and a higher silica and higher alumina-iron oxide content. These two series of burns, having produced cements of both normal composition, containing less than 2% magnesia, and abnormal composition, containing over 25% magnesia, should, with the complete studies of their chemical, petrographic and physical properties, extending over long periods, give a clear idea of the effect of magnesia in Portland cement when it replaces lime. However, in this paper the results of the strength tests of the second series do not extend beyond 6 mos. and the strength of the cements of the first series beyond 12 mos. in the case of the neat and sand specimens, and beyond 18 mos. in the case of the concrete specimens.

The results obtained with the second series are so similar to those obtained with the first, that the reader is referred to the summary, given in CONCRETE-CEMENT AGE for Mar., 1914, p. 38, Cement Mill Section.

ELEVENTH ANNUAL BANQUET

The 11th annual banquet of the Institute was held Friday evening, Feb. 12, at the Auditorium hotel with about 200 in attendance. It was the occasion for a tribute to Richard L. Humphrey for his service to the Institute and his achievements as a recognized leader in the field of concrete development. Percy H. Wilson made the address, presenting Mr. Humphrey, on behalf of his friends and associates in the Institute, with a very handsome clock. A smaller clock of similar design was presented to Edward E. Krauss, the retiring secretary, with an expression of appreciation of his valued services. With the fun-making of the toastmaster, Douglas Malloch, and the leadership in song-making by Robert Hall the occasion was one of unusual good spirit. There was a note of humor in the toastmastership. That Mr. Malloch is one of the editors of a lumber paper—*The American Lumberman*—did not in the least, however, affect his acceptability at a concrete banquet.

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[44] Deputy Chf. Engr., N. Y. Bd. of Water Supply, N. Y. C.

[45] *Journal*, Am. Concrete Inst., Vol. III, No. 2, p. 10, Feb., 1915

[46] Contg. Engr., Seattle

[47] N. Y. City

[48] Described in CONCRETE-CEMENT AGE, Oct., 1914, p. 181

[49] Chem., Bur. of Standards, Pittsburgh

[50] CONCRETE-CEMENT AGE, Mar., 1914, pp. 29-33, Cement Mill Section, and *Journal*, Am. Concrete Inst., Vol. II, pp. 470-84, Dec., 1914

Concrete Lighting Standards for Bridges at Houston, Texas

By W. W. Washburn[1]

Concrete lighting standards are being used on several reinforced concrete bridges at Houston, Tex., among them being the San Jacinto St. bridge described in Concrete-Cement Age for Aug., 1914. Details of these standards are shown in Figs. 1, 2 and 3. They are made of a variety of different materials, the handsomer standards consisting of 1 part White Portland cement to 2 parts crushed New England granite, with a small percentage of a waterprofing compound. Standards are also made with 1 part of ordinary gray Portland cement and 2 parts of coarse torpedo sand. These standards are mostly used where economy is an object, or where it is desirable to have the standards harmonize with other structures of ordinary gray concrete, and especially for bridges.

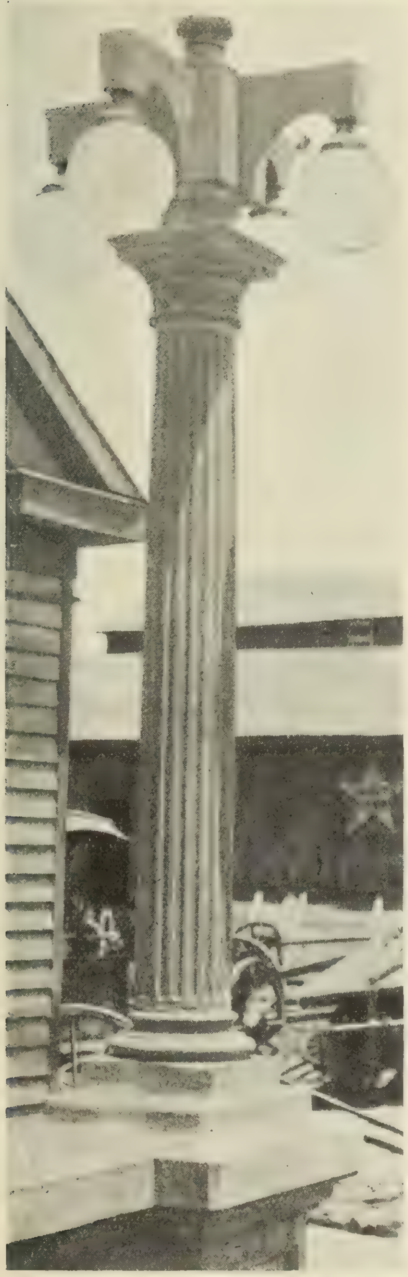

Fig. 1—Concrete Lighting Standard for Concrete Bridges, Houston, Tex.

MANUFACTURE OF STANDARDS

The standards are molded in heavy, rigidly fastened steel and iron molds, the material being mixed with as large a percentage of water as can be used without causing it to stick to the molds or showing bubbles on the surface. As an extra precaution a mold wash is used to prevent the material from adhering to the sides of the molds. The tamping is done with very rapid, light blows, but a small amount of material being added at a time. The reinforcement consists of corrugated steel bars[2], the size and number being, of course, varied with size and the length of the colmns.

The columns are allowed to remain in the molds until they have obtained their initial strength and thus have strength enough to sustain their own weight. After the molds are removed the standards are sprinkled with a very fine spray which has the effect of removing the surface film of cement and exposing the aggregates. This treatment is especially desirable kept in a damp atmosphere and in the case of standards made of granite concrete. The standards are sprinkled twice a day for 2 wks. or 3 wks., after being molded.

In addition to the granite concrete and the natural gray concrete previously mentioned, the standards are also made of a Bedford stone shade, light buff, pearl gray and a variety of shades or colors. For interior work the standards may be made of crushed marble and cement and rubbed to a polished surface similar to the work done in connection with terrazzo floors. Pure white standards made of white silica sand, crushed marble and white Portland cement have proved very attractive for localities which are not exposed to the smoke and grime of manufacturing localities.

The standards are seldom painted

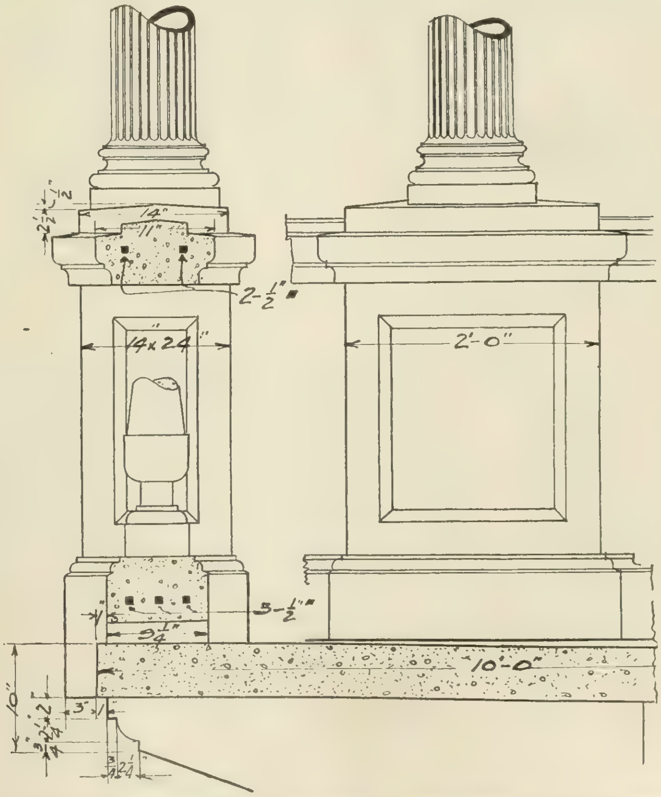

Fig. 2—Details of Elevation and Section of Illumination Column Pedestals and Balustrade Rails

and such treatment is neither necessary nor desirable, but when there are special reasons for painting the standards some particular shade or color they are previously prepared to receive the paint by giving them a surface treatment of zinc sulphate solution. This has the effect of converting any free lime into insoluble compounds so that the linseed oil of the paint is not affected.

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[1] Res. Engr., Dept. of Bridges, Houston, Tex.

[2] Corrugated Bar Co., Buffalo

Concrete has proven the most ideal possible material for this purpose as all other materials are either excessive in cost or subject to rapid deterioration and many materials which have either been used or suggested for the purpose have both faults. The concrete is inexpensive, defies both time and the elements, requires no painting, repairs or attention and is so inexpensive that the designs may be in correct proportions.

SHIPMENT OF STANDARDS

The concrete lighting standards for the several bridges at Houston were shipped from the factory at Terre Haute, Ind., in carload lots and assembled at the sites where required. Each standard is shipped in several parts such as the base, shaft, collars, capital, cross-arms, etc. Almost any design is available, the ones used here having a Doric capital, as shown in Fig. 1. These standards may be obtained in any length and may be placed on the sidewalk or on top of bridge balustrade. The standards used here are placed on pedestals which form a part of the balustrade, as shown in Figs. 2 and 3.

DESIGN AND ERECTION OF STANDARDS

The standards are constructed with a hollow shaft of about 2″ in the center of the post. At the top conduits run out into the four cross-arms from a central junction box. Four 9-in. white globes are placed in a pendant position at the extremities of the cross-arms and a 12-in. globe is placed at the top, in the center. A 1-in. conduit runs from a manhole or other connection up through the pedestal and through the hollow shaft in the standard to the junction box at the top. When pedestals are concreted small reinforcing bars are placed close to the 1-in. conduit.

In placing the standard each separate part is placed and leveled and a very thin bed of mortar placed between separate parts. When all of the parts are in position and plumbed properly, thin, rich grout is poured into the opening at the top and flows around the reinforcing bars and the conduit which run up through the standard. When this grout sets the standard is, for all practical purposes, a part of the pedestal.

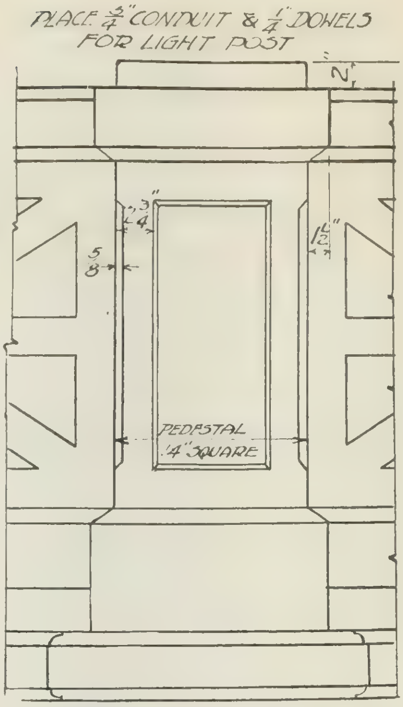

Fig. 3—Side View of Pedestal for Light Post

The globes are fastened to bronze fittings or holders with bronze screws.

The cost, f. o. b. factory, of each natural gray concrete standard was as follows:

Standard	$10.00
4 9-in. white Alba globes and 1 12-in. white Alba globe	4.00
5 cast bronze holders for globes	4.00
Total	$18.00 for each standard

This is remarkably low in comparison with the cost of the average design in cast iron.

The standards were manufactured by the Pettyjohn Co., Terre Haute, Ind.

The Fire Protection of Structural Members

The Insurance Inst., Manchester, England, has just awarded a prize for the best essay on reinforced concrete construction to S. Broadbent. After dealing with the early history of reinforced concrete in England and with the general methods of preparing concrete, the writer devoted the bulk of his paper to the fire protection of structural members. On this subject he said:

> It is a well-known fact that concrete, when subjected to intense heat of about 1,000° F. or over, for a continuous period will lose a part of the water taken up in crystallization. This is known as dehydration, and when dehydration is complete the strength of the concrete is destroyed.
>
> Dehydration, however, is a very slow process, and will, even in the most severe fire, only extend to the depth of 1″ of the concrete, although cracks may extend further. Dehydrated material, being a poor conductor of heat and generally remaining in place for some time at least, protects the mass of concrete from further dehydration.
>
> It is not good practice, as a general proposition, to use the same material for structural duty and for resisting fire. The fire alone will give stresses enough for the material to resist without having to resist any structural load.
>
> If the quantity of concrete on the outside of a reinforced column or beam is increased so as to allow a loss of the material during a fire without affecting the load-bearing quality of the structural member, the additional material added for fire-resisting will participate in the load carrying, in spite of all that is done, and this would render it less able to resist a fire.
>
> Furthermore, should the fire be so severe as to cause dehydration, cracks may extend beyond the dehydrated portion to the steel reinforcement, with obvious results, owing to the column or beam covering being a homogeneous material.
>
> The ideal way to protect a structural member would be to construct that member as a unit of sufficient strength to withstand all structural loads, and then to place the fire-protective covering on separately. This would allow dehydration without affecting the load-bearing quality of the member, and, also, should cracks occur, it is probable that they would not extend further than the covering owing to its separate construction.
>
> For this reason, to insure a first-class fire-resisting risk, a thickness of 1″ of concrete on the outside of a structural member is, to my mind, sufficient for a separate fire protective covering for a reinforced member, while 3″ should be regarded as necessary if the fireproofing is incorporated with the material for the column itself.
>
> The above, however, should be regarded as a general statement, the covering necessary being dependent upon the class of trade for which the building is to be used and the likelihood or otherwise of a fire therein attaining a high temperature, and discretion should be used in specifying whenever an opportunity occurs, which I think will not be very frequent under existing conditions, owing to the extra cost involved by separately protecting a reinforced member.
>
> It is my personal opinion that the rules applicable to buildings of fire-resisting construction could, with advantage, be revised and extended, as also could the discounts allowed, particularly in regard to buildings of reinforced concrete construction.

The use of building paper in lining forms needs constant attention in order to secure satisfactory results. The paper is easily torn in placing reinforcement and in shifting the forms, requiring much patching. It is also somewhat difficult to keep the paper absolutely smooth so that the final surface does not show any wrinkles.

Synthetic Stone as Used in the Construction of Catskill Aqueduct Buildings[1]

By H. Lincoln Rogers[2]

[*In connection with this important paper by Mr. Rogers on Manufactured Stone, this magazine is able to present, with the illustrations supplied by the author, some additional illustrations from photographs of other interesting work in concrete stone. These additional plates show work of the same manufacturers whose products are described by Mr. Rogers.*—Editors.]

Catskill mountain water, delivered, in N. Y. C. in the tremendous volume of 500,000,000 gals. daily, is the plan of the Bd. of Water Supply of N. Y. C. The work extends from Ashokan reservoir, 12 mi. west of Kingston, into various boroughs of N. Y. C., a distance approximating 125 mi. The valve-operating and unwatering machinery, necessary for the operation of the aqueduct, is planned to be housed in 53 buildings, located as needed at the headworks and along the line of the aqueduct.

Synthetic stone, as a building material, worthy of serious consideration for use in these buildings, was first brought to the writer's attention about eight yrs. ago, by Alfred D. Flinn, at present deputy Ch. engr. of the Board, who had observed successful applications of its use in Boston. Subsequent investigations, experiments and tests of this material have since been continuously carried on jointly by Mr. Flinn and the writer.

Inquiries, begun in 1906, to ascertain the names of experienced and reliable manufacturers, showed a sufficient number to warrant open competition in public letting. Numerous plants were then visited and close observation made of the methods and care with which the details of manufacture were carried on at each place.

The kinds and quality of aggregate, the grading, proportioning, mixing and curing were carefully examined, including the means employed for maintaining a constant agitation of the mix, until poured into the molds. The organization, plant lay-out and general equipment for handling large work were also noted.

Each manufacturer visited was requested to show buildings or structures in which his product was used, either in a large or a small way. Such structures were examined closely for crazing or cracking, effects of weathering and general appearance, particularly in contrast with available natural building stones.

The product of other concrete-stone manufacturers was similarly investigated when brought to our attention.

These preliminary investigations were highly favorable to synthetic stone, but not fully conclusive. If satisfactory, it was evident that the use of this material in the Catskill aqueduct buildings offered many opportunities to effect economics and yet indulge in architectural designs that would be extravagant if produced in acceptable natural stone. It was also apparent that with the rapid growth foreseen for this product many amateurs would enter this field, and inexperienced manufacturers, producing doubtful and inferior material, would have to be reckoned with. Great care would also have to be exercised in drawing the specifications and contract for public letting so as to secure synthetic stone of the best quality and only that manufactured by skilled, experienced men in well organized and equipped plants.

In most instances it was found that the best manufacturers were eager to profit by suggestions in regard to improving the artistic appearance of their product, which in many aspects was lacking from an architect's point of view. For instance, much of the synthetic stone was dull, lifeless and timid in ap-

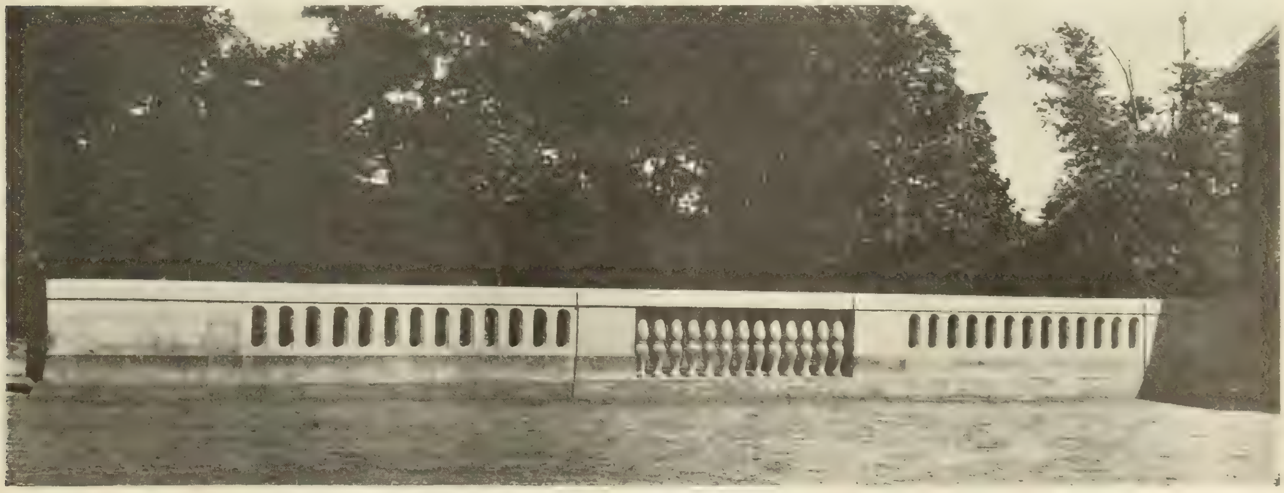

Fig. 1—Sample of Concrete Stone Balustrade for Ashokan Bridge, Catskill Aqueduct

pearance and lacked the variations, color and charm usually found in most natural stones.

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[1] Presented at the 11th Annual Convention, Am. Concrete Inst., Chicago, Feb., 1915

[2] Archt., Bd. of Water Supply, N. Y. C.

There seemed no reason why synthetic stone should not shake off its uninteresting monotone and cement shroud. To overcome this and to secure the appearance of natural stone tints, the admixture of small proportions of mineral color, hornblende, black marble and similar natural colored aggregates was experimented with. First results along this line were not very happy and suggested the made-up appearance of the stage and not the tint of Nature. After many experiments and trials and the expenditure of much time, this "made-up" appearance was overcome and the results produced variegated, accidental tones in several chosen, warm, mellow shades, each developed as a general color scheme suitable for an entire building or group of buildings.

Attention was then directed to the surface finish. Few of the manufacturers had given effective thought to procuring that wide range in texture—so familiar and attractive in natural stone. In this line also any attempted advance or departure from the familiar but uninteresting mechanically grooved 4-cut and 6-cut work or rubbed surfaces seemed to have been timid and ineffective. A few of the manufacturers, however, had made creditable progress.

Eventually a complete set of specimens was produced which satisfactorily ran the whole gamut of natural stone texture, including some interesting variations made with a sandblast before the stone was very hard.

From the very beginning a collateral series of tests was conducted, in conjunction with the observations above described, at the laboratory of the Board of Water Supply. Samples of staple and special output from the factories visited were here subjected to tests under prescribed regulations which required that an inspector of the Department of Water Supply should visit the factory and take pourings from the regular commercial output—in molds 2″ x 4″ x 8″ in size, and cylinders 8″ in diam. and 16″ long. These were marked for identification by the Board's inspector and shipped to the Board's laboratory for tests when 28 das. old. Half specimens from transverse tests were used for absorption tests.

The schedules in Tables 1 and 2 are fair examples of the tests on acceptable manufacturers' products.

TABLE I—COMPRESSIVE AND TRANSVERSE TEST OF CONCRETE-STONE

Contract 121—Specimens made at works of contractor

Spec. No.	Compressive lbs per sq. in., 28 da.	Size of specimen	Transverse Load, lbs.
A-1	....	2″x4″x8″	1.340
	....	2″x4″x8″	1,460
	....	2″x4″x8″	1,540
A-2	....	2″x4″x8″	1,820
	....	2″x4″x8″	1,830
	....	2″x4″x8″	1,930
A-3	3,145	8″x16″	
	3,220		
	4,250		
A-4	4,540		
	3,735		
	3,095		

Note: A-1 and A-3 cast in rigid molds
A-2 and A-4 cast in sand molds

TABLE II—ABSORPTION TEST OF CONCRETE-STONE

Spec. No.	Wt. after drying	Wt. after 48 hrs. im.	Absorp.
0 15	1,466.0	1,517.0	3.5
0 16	1,120.6	1,161.8	3.6
0 17	1,362.3	1,411.5	3.6
0 18	1,209.6	1,248.1	3.2
0 19	1,268.6	1,305.7	2.9
0 20	1,552.5	1,596.5	2.8
Average			3.3

Comparative estimates of cost, based on tentative designs, were made between structures embodying good, acceptable, durable, synthetic stone, various available natural stones and combinations of suitable brick and natural stones. These estimates showed economies in the use of synthetic stone ranging from 10% to as high as 35%, varying according to the simplicity or ornateness of the architectural designs.

Satisfied with the results of physical tests, assured of economies and freedom in design, plans and specifications were prepared for five buildings to be faced with synthetic stone simulating granite of a pinkish hue. The specifications required the contractor to submit for approval the name and address of the manufacturer from whom it was proposed to order the synthetic stone, also the names of at least three buildings not less than five years old in which the product of the concern might be seen exposed to weather. Large samples showing surface finish and color tone were required to be submitted for approval before placing the order.

The specifications also demanded the following requirements:

Test specimens of the concrete-stone shall be made under the observation of the engineer or architect, from the concrete mixture being used in the manufacture of concrete-stone. There shall not, however, be demanded more than five sets of three specimens each, for any building, unless some of the tests show that concrete-stone of unsatisfactory quality is being produced.

Test specimens each 2″ x 4″ x 8″ in size, not less than 28 das. old shall, when placed flatwise on supports 7″ apart, sustain without fracture a transverse center load of 1,000 lbs.

Test cylinders 8″ in diam., 16″ long, not less than 28 das. old, shall support when dry, without cracking, a compressive load of 2,500 lbs. per sq. in., each specimen being properly supported on its bed.

Half specimens from transverse tests after drying at about 180° F. to constant weight shall be placed in water flatwise so that their upper surfaces are ½″ above the surface of the water and shall so be maintained for 48 hrs. At the expiration of this time the upper surfaces of the specimens shall be dry, and no specimen shall have absorbed more thas 4% by weight of water.

All concrete-stone shall be sufficiently reinforced with steel to withstand transportation and erection and to prevent cracking from any cause. All lintels and similar members shall be additionally reinforced to carry the loads to be borne. Each stone shall be provided

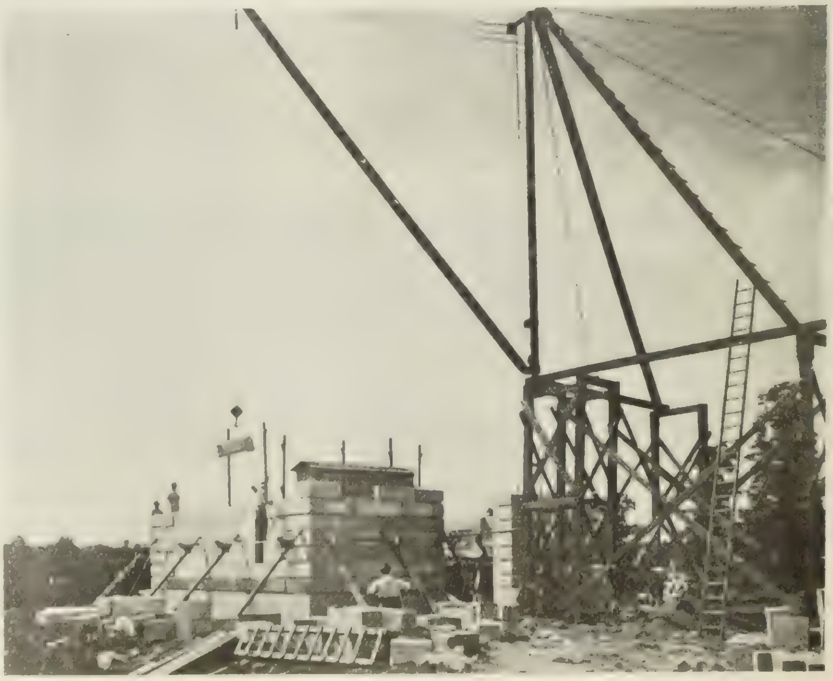


FIG. 2 SETTING MANUFACTURED STONE FOR BOARD OF WATER SUPPLY

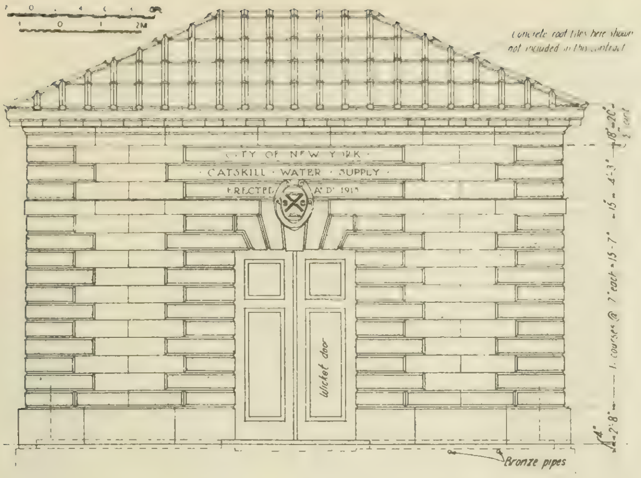

Concrete roof tiles here shown not included in this contract
CITY OF NEW YORK
CATSKILL · WATER · SUPPLY
ERECTED A.D. 1913
Wicket door
Bronze pipes

Fig. 3—Front Elevation, Siphon Chamber, Catskill Aqueduct, Built of Manufactured Stone

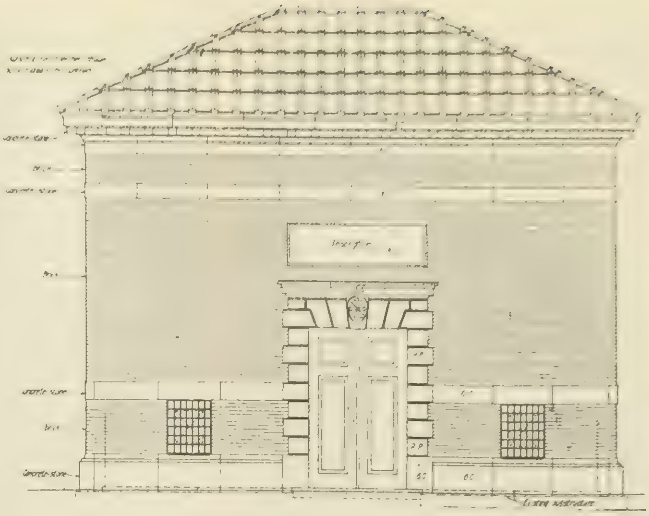


Fig. 4—Aqueduct Building—Elevation—of Brick and Concrete Stone

with a suitably placed lifting ring or other device for handling it without marring the revealed faces.

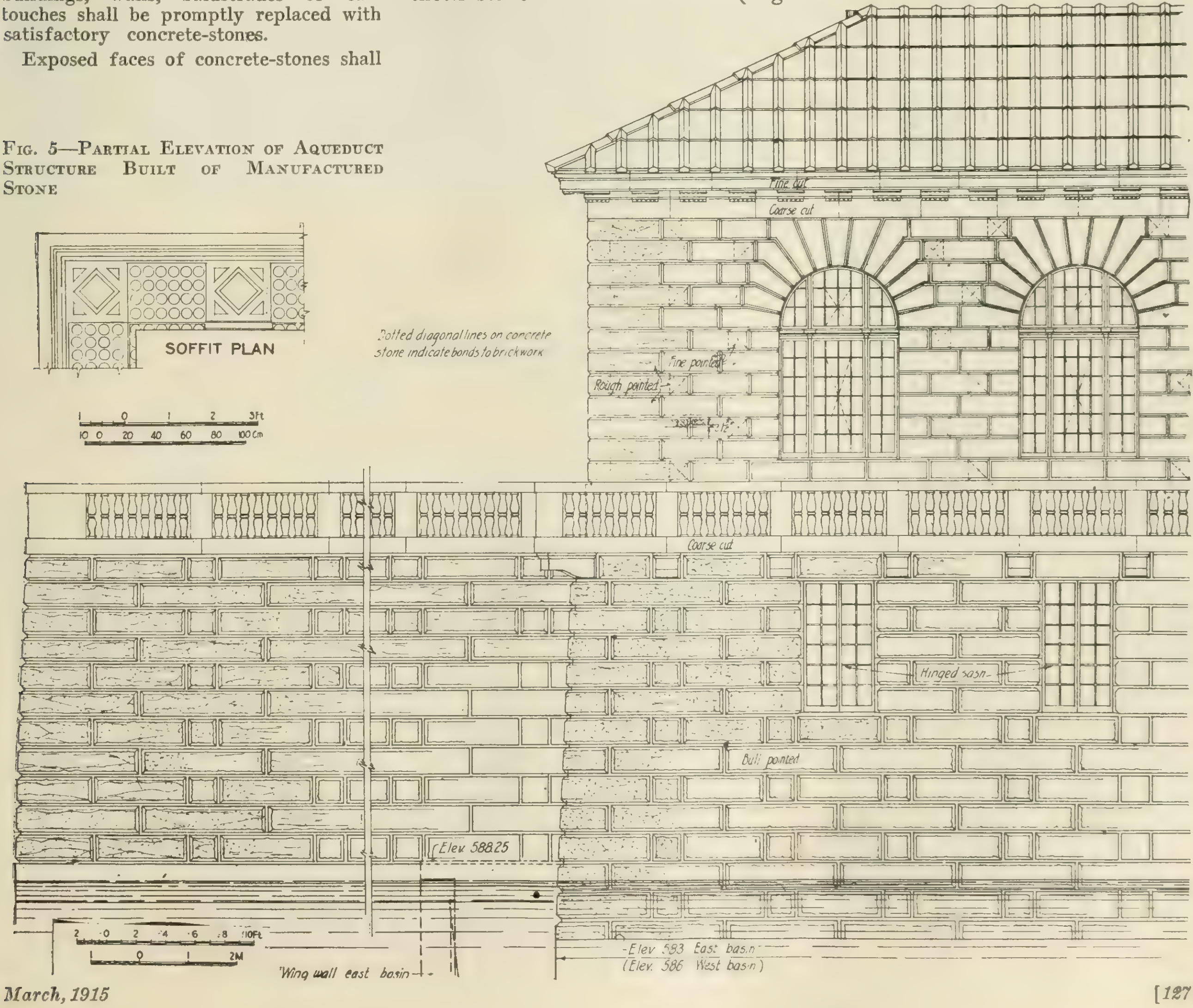
Concrete-stone shall be manufactured sufficiently in advance of the requirements of erection to have attained an age of about 2 mos. before shipment unless permission be given to ship sooner on satisfactory evidence that the concrete-stones will not be damaged thereby. * * * * Any concrete-stones marred before their acceptance in the buildings, walls, balustrades or cartouches shall be promptly replaced with satisfactory concrete-stones.

Exposed faces of concrete-stones shall be tooled equivalent to approved samples, in general similar to the following kinds of stone-cutting: Bull pointed, rough pointed, fine pointed, or patent hammered, four, six or eight cuts to the in. * * * *. Other styles of finish of approximately equal cost may be ordered or approved for any concrete-stones.

Emerson & Norris Co., New York and Boston, supplied the synthetic stone for our first work (Fig. 2). Specimens of the mix as poured for the work were taken from time to time and tested for transverse and compressive strengths and for absorption.

The stones were delivered at the work and set, care being taken to roughen the beds slightly in order to get a good bond. (See Fig. 2).

Fig. 5—Partial Elevation of Aqueduct Structure Built of Manufactured Stone



As each building was completed the synthetic stone was tooled in place. (See Figs. 15 and 16.) Several advantages resulted from this method. Stones on which arrises were marred in transportation or handling were set forward sufficiently to permit new arrises to be cut when tooled, at little expense; contrast in texture was better judged and desired modifications not seen at the shop were made possible, whereas in the shop at best only a limited number of tooled stones can be piled up for inspection. The stones have had more time to harden and the tooling is thus made sharper and more crisp. (Fig. 13). All mortar slop, rust from steel work and other stains are entirely removed in this way and the stonework left thoroughly clean.

The next contract let comprised seven buildings of brick with synthetic stone trim. (Fig. 4.) The brick used were the culls of shale paving brick 3⅛" x 4" x 9", laid up with raked-out 1-in. white cement mortar joints. These culls, due to their bent and twisted faces, of varying red shades ranging to a blue-black, gave a general tapestry brick effect on a large scale, harmonizing well with the purpose of the building, its size and setting.

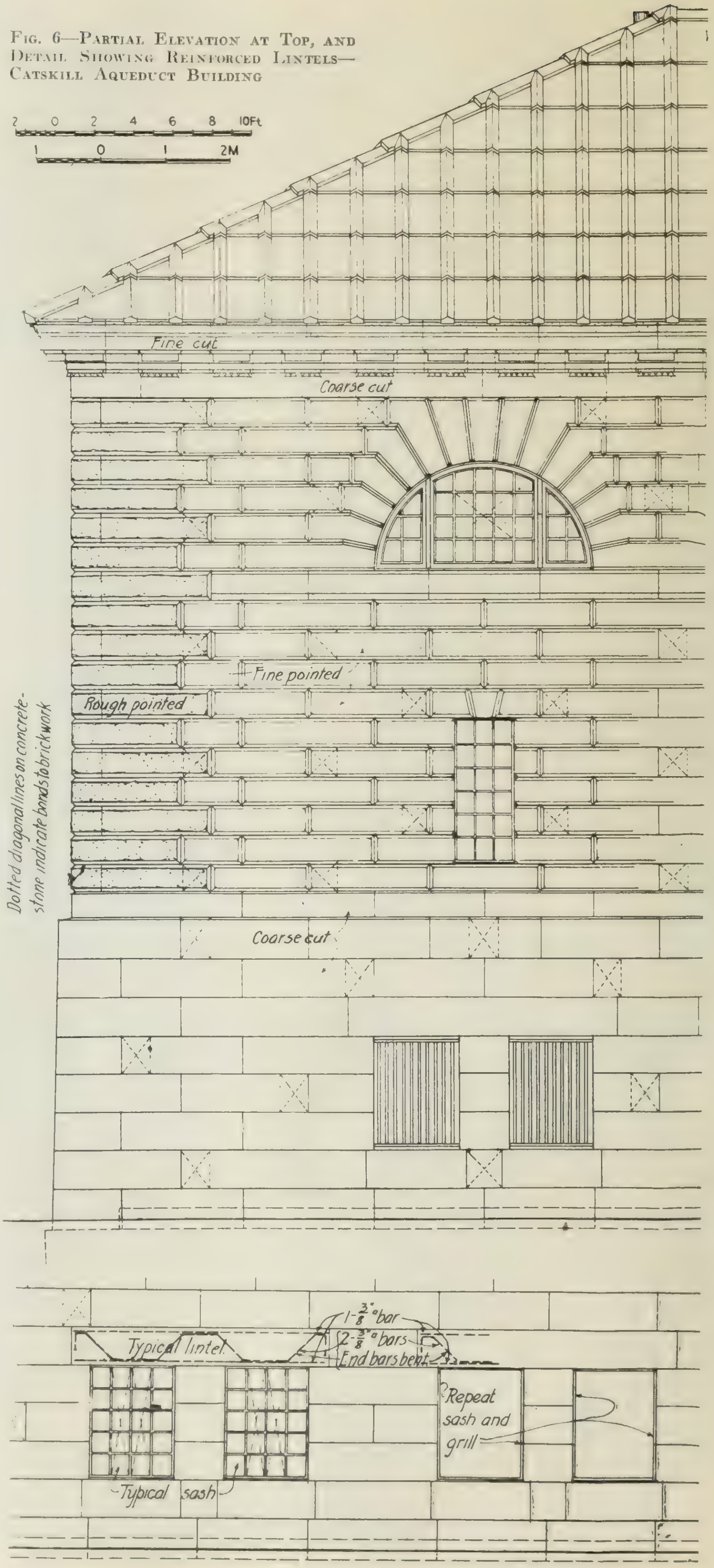
The synthetic stone for this set simulated buff sandstone and was produced by the admixture of mineral pigment[3]. Added character was furnished by the aggregate, which included Gouverneur marble, white and blue.

The Onondaga Litholite Co., Syracuse, N. Y., through the Watson Engineering Co., N. Y. C., furnished the stone for this work. This synthetic stone was entirely cut at the factory in Syracuse. (Figs. 17 and 21). Several specimen stones were first cut and tentatively approved, after which an entire doorway was cut and set up in the factory for criticism.

The synthetic stone delivered for these buildings were highly satisfactory and the work progressed with no delay due to delivery of concrete-stone.

The next contract was for nine buildings, and the balustrades and cartouches for a bridge at or near the Ashokan reservoir. This work contained about 100,000 cu. ft. of synthetic stone (See Figs. 5 and 6) and balustrade and cartouches for bridge (Figs. 19 and 20). There are about 2,500′ of bridge balustrade. Estimates made during the preparation of the drawings and specifications showed the volume of synthetic stone contained in this contract, probably the largest single order

Fig. 6—Partial Elevation at Top, and Detail Showing Reinforced Lintels—Catskill Aqueduct Building



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[3] Clinton Metallic Paint Co., Clinton, N. Y.

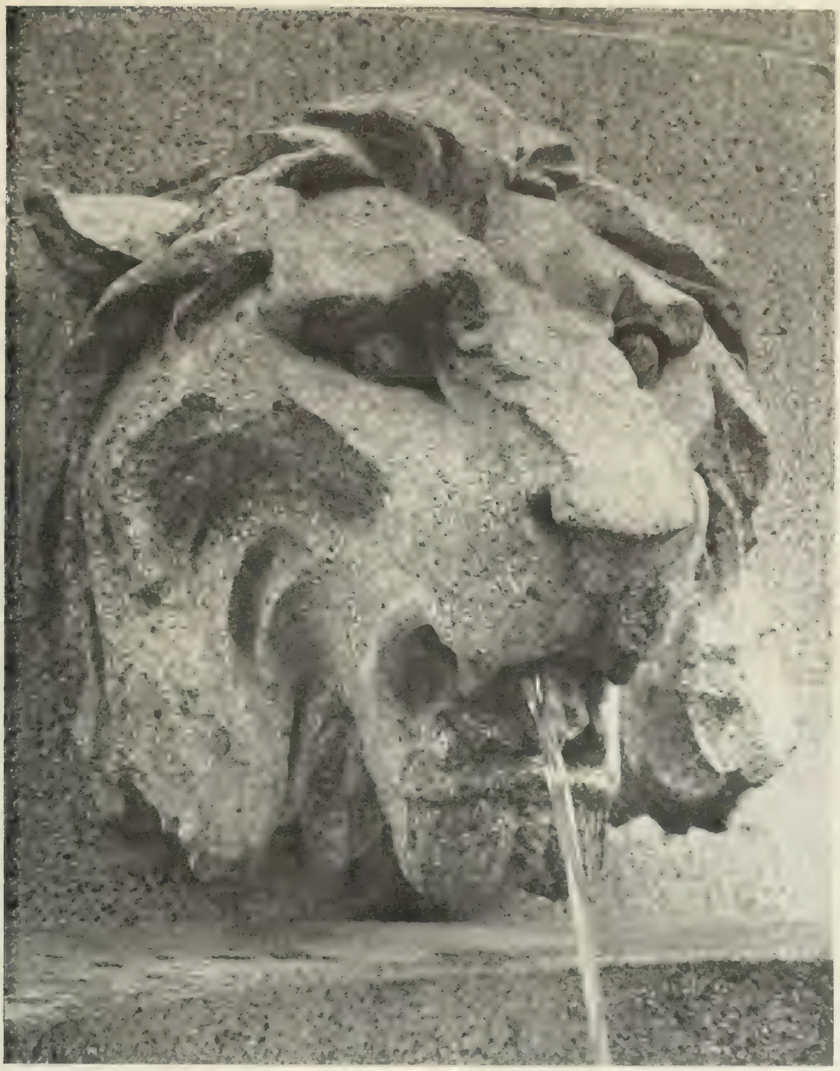
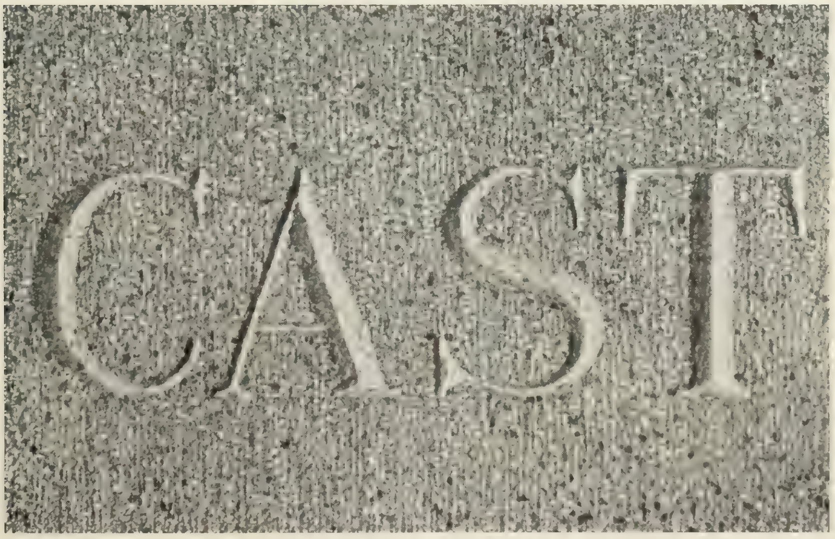


Fig. 7—Detail of Lion's Head of Fountain Shown in Fig. 10

Fig. 8—Detail To Show Texture of Tooled Surface of Concrete Stone—Emerson & Norris Co., Manufacturer



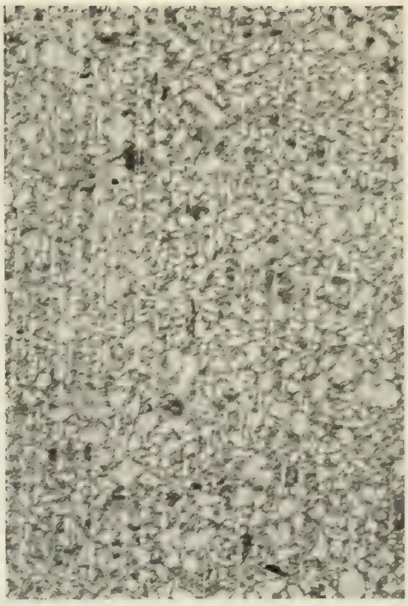


Fig. 9—Detail of Parallel Tooled Concrete Stone Surface

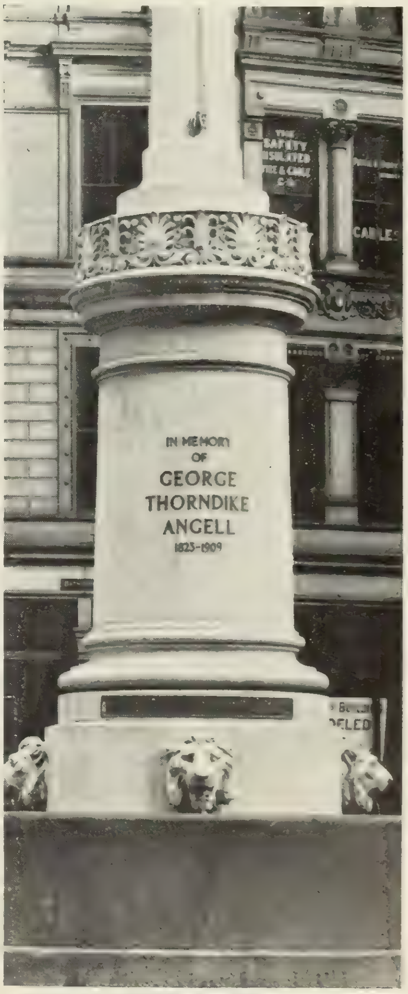
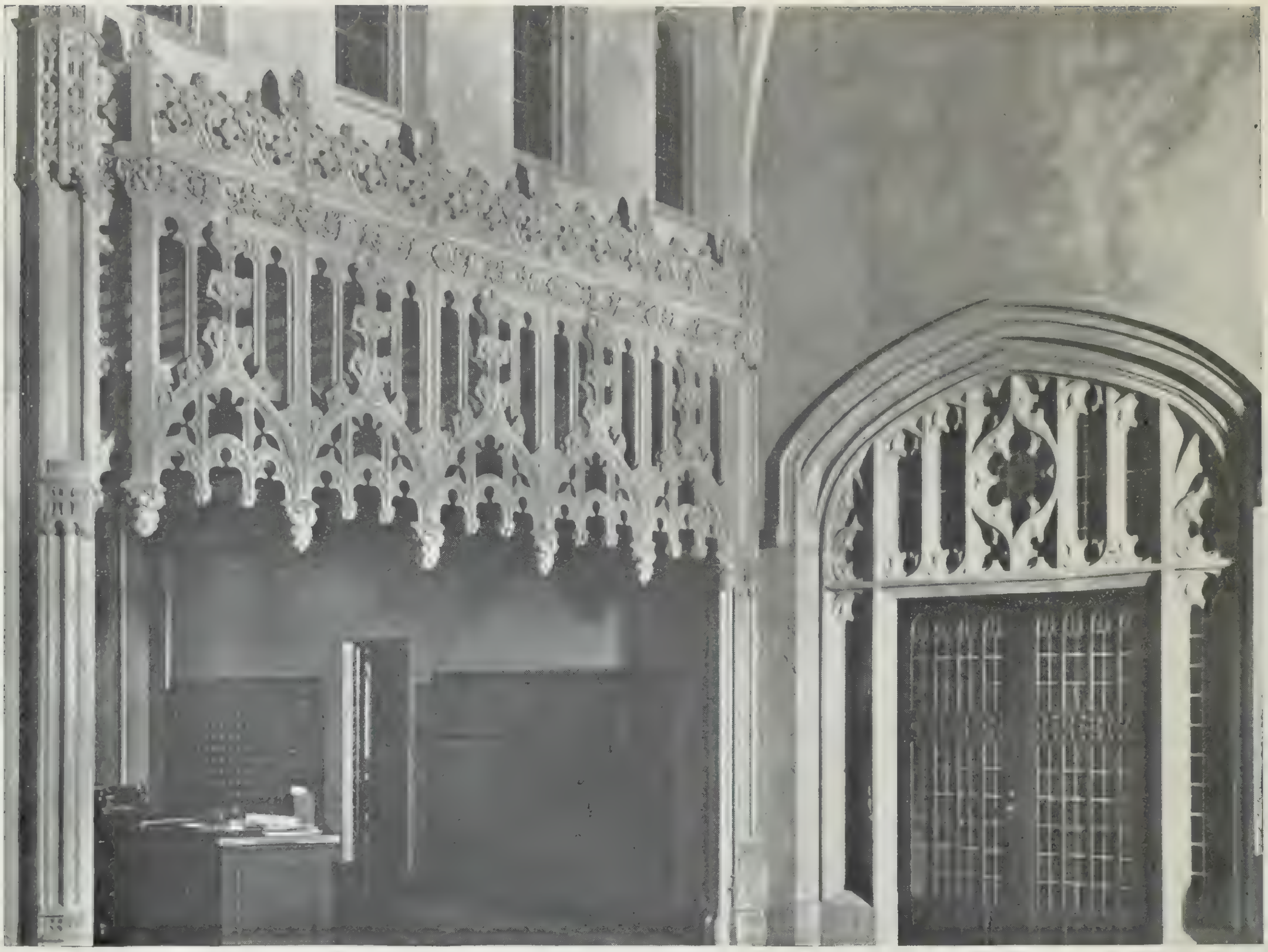


Fig. 10—Angell Memorial Fountain, Boston, Built of Concrete. By Emerson & Norris Co.



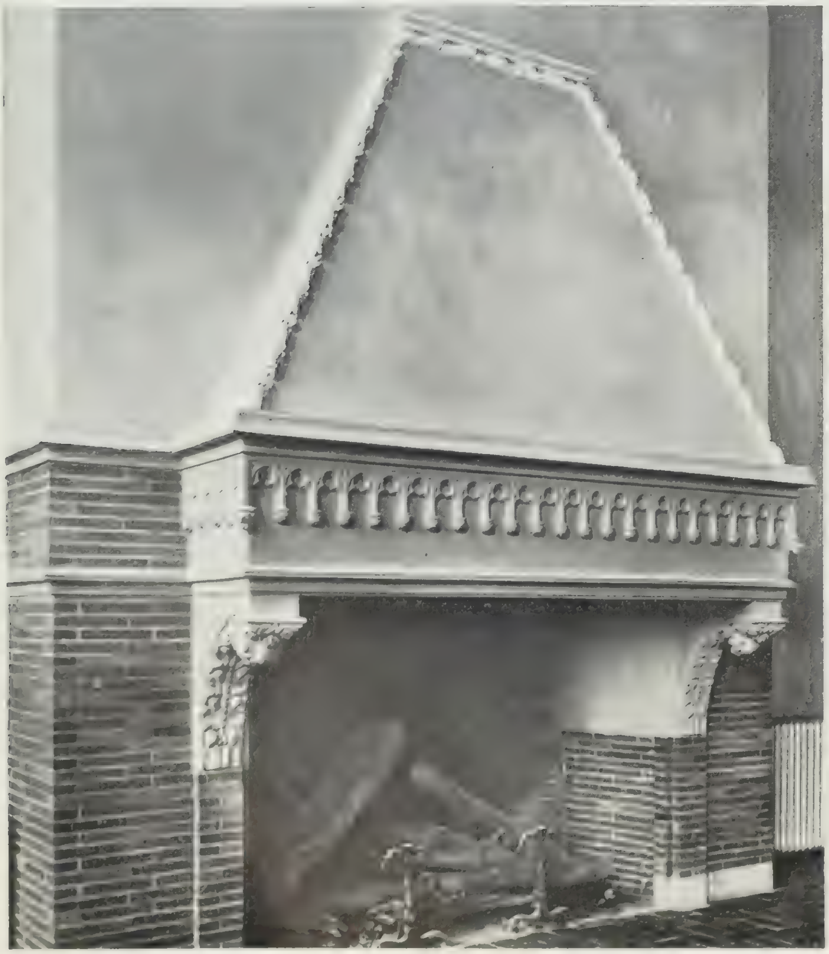
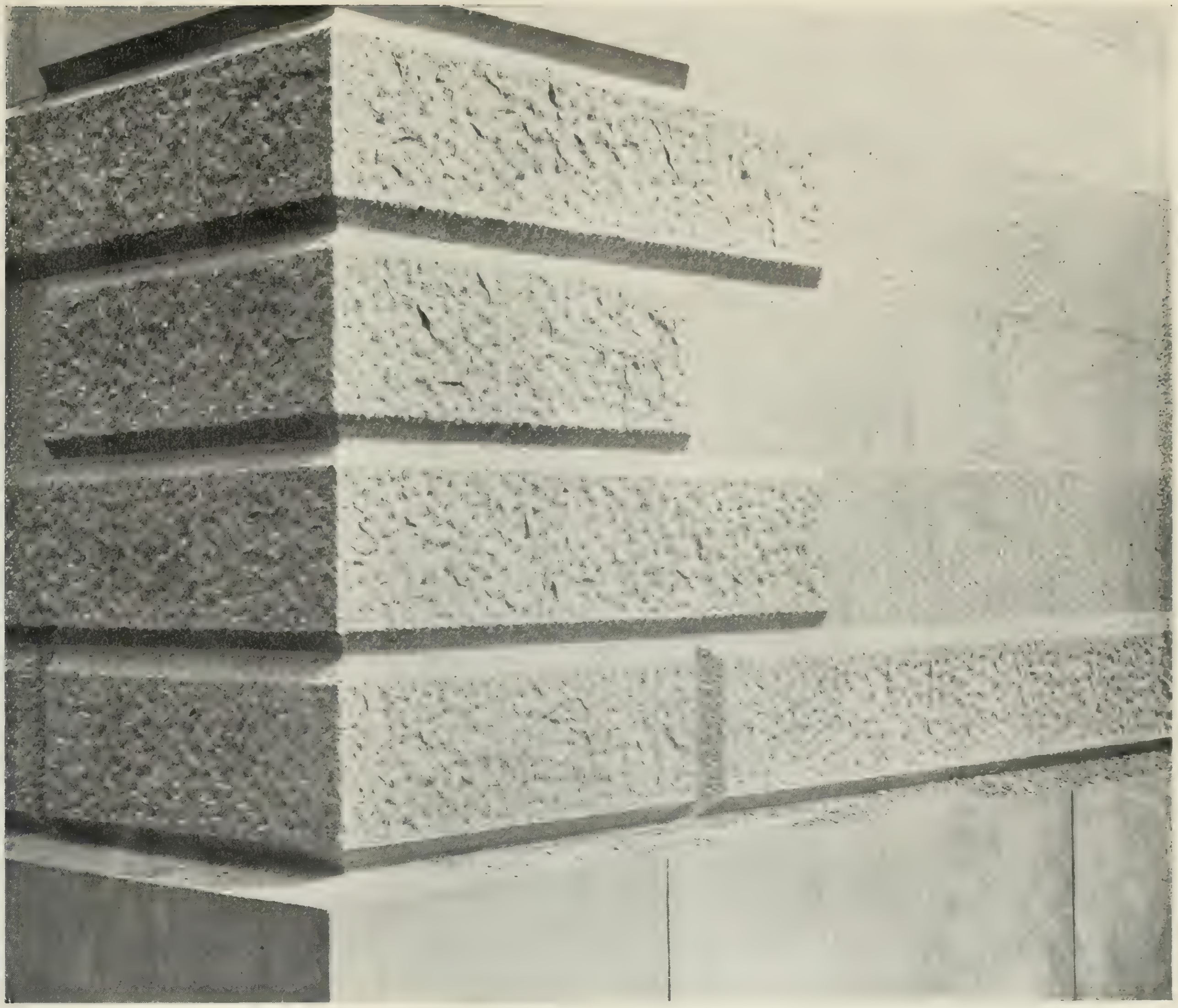


Fig. 11—Reinforced Concrete Screen, Hand Carved, Hamilton College Library, Clinton, N. Y.; Made by Onondaga Litholite Co., Syracuse

Fig. 12—Concrete Fireplace Trim, Hamilton College Library, Made By Onondaga Litholite Co.



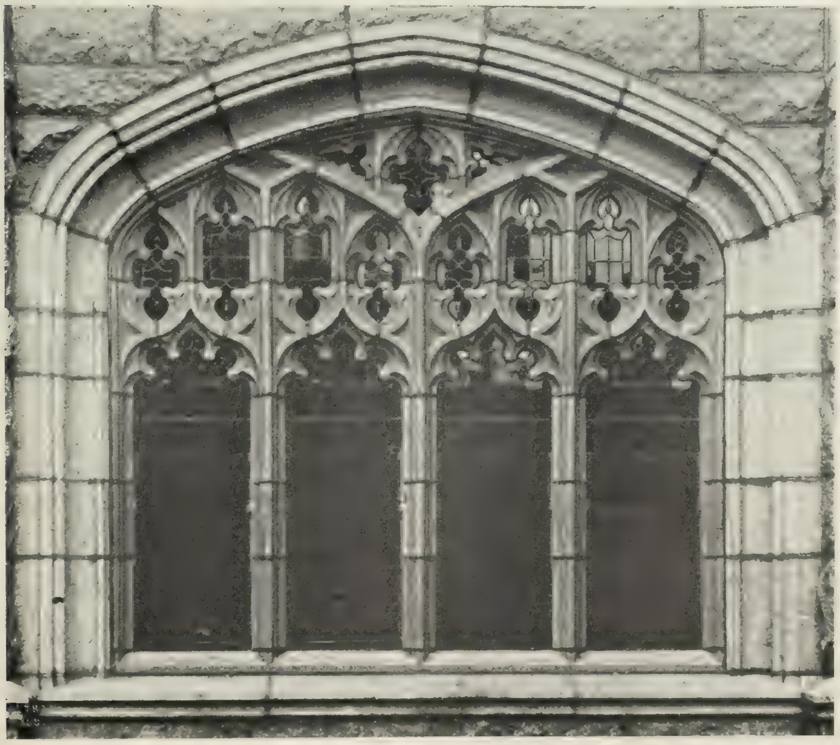
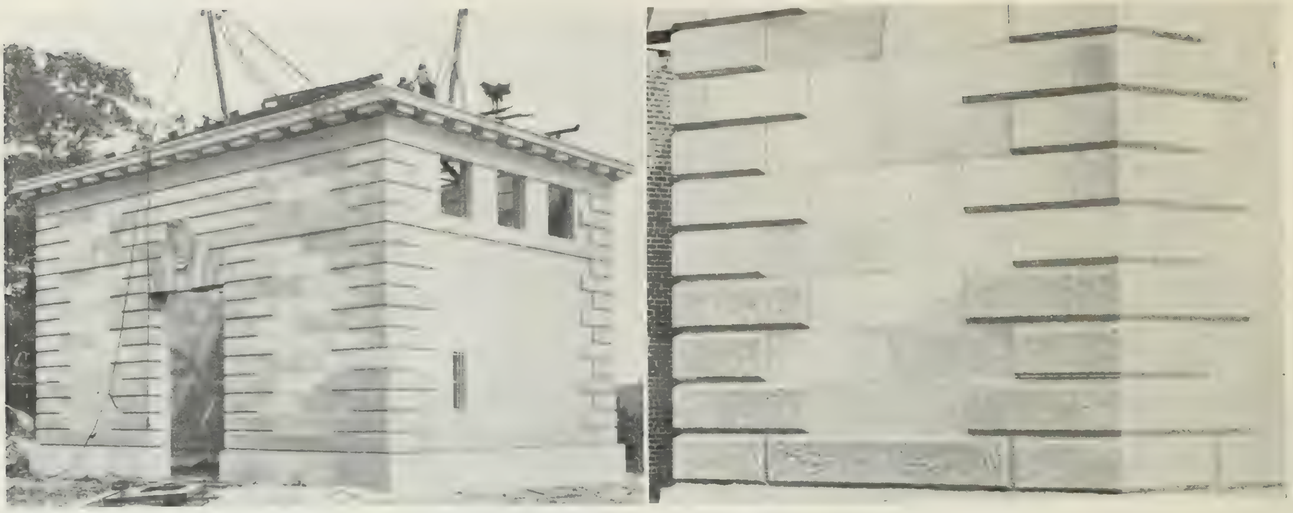


Fig. 13—Concrete Stone, Tooled in Place, Catskill Aqueduct Building

Fig. 14—Concrete Window Tracery, Memorial Church, Fall River, Mass., Made By Emerson & Norris Co.



Figs. 15 & 16—General and Detail Views Concrete Stone Tooled in Place, Catskill Aqueduct Building

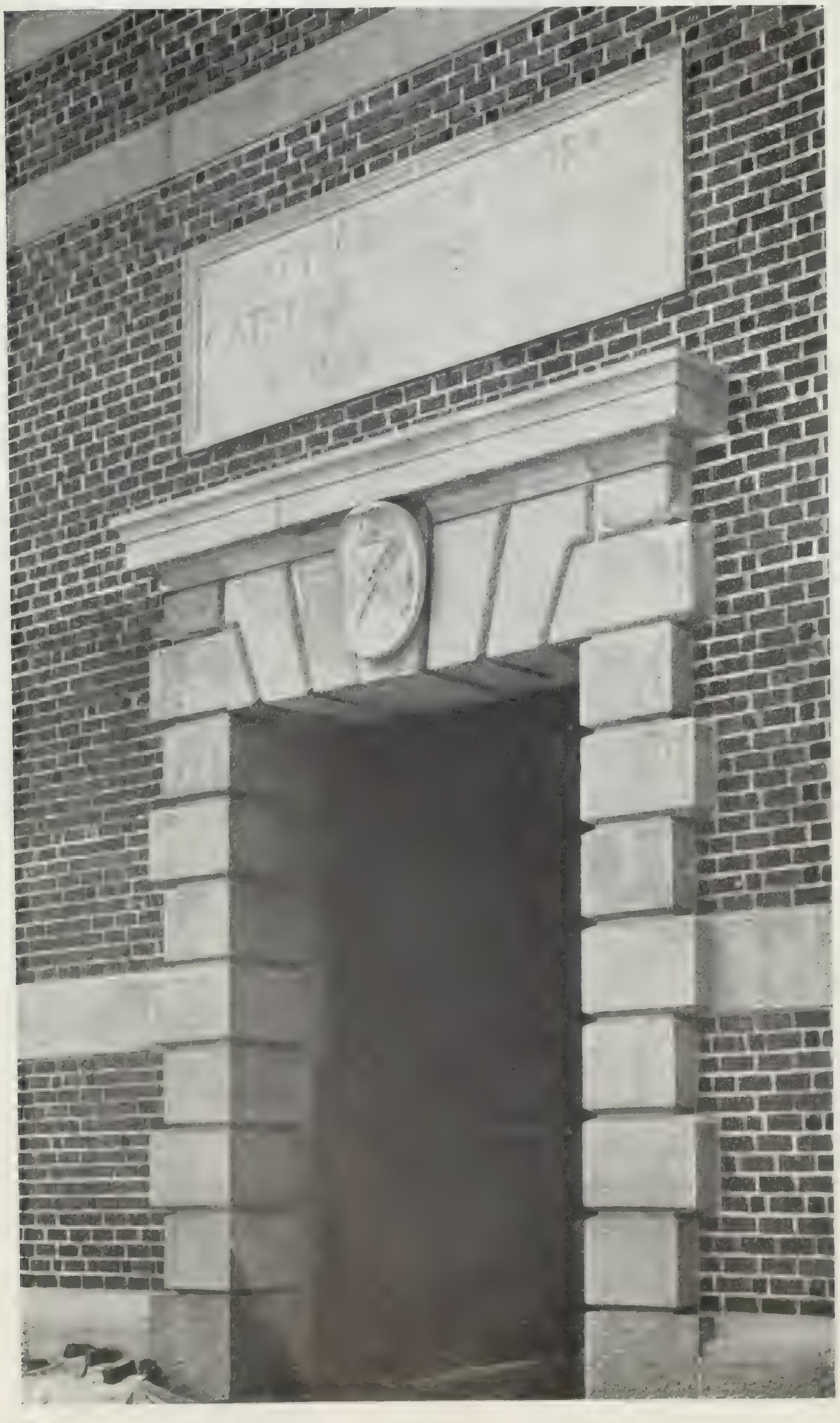


Fig. 17—Concrete Trim Stone, Tooled at Factory—Catskill Aqueduct Building

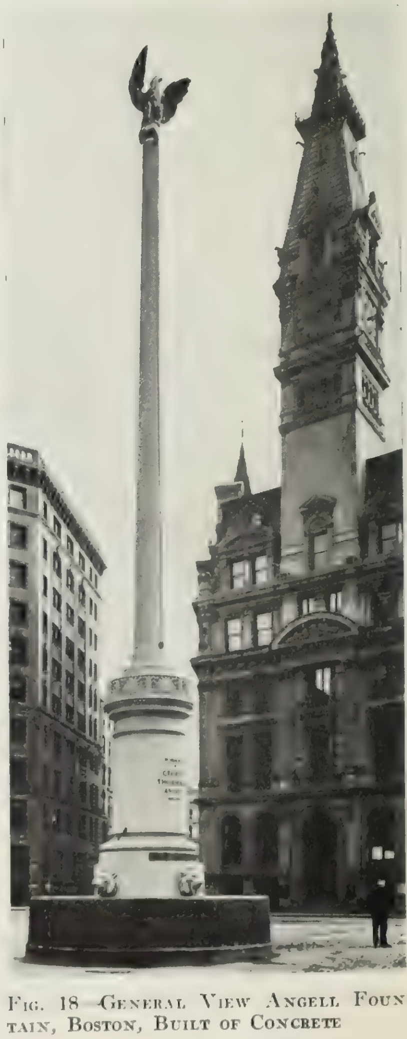


Fig. 18—General View Angell Fountain, Boston, Built of Concrete

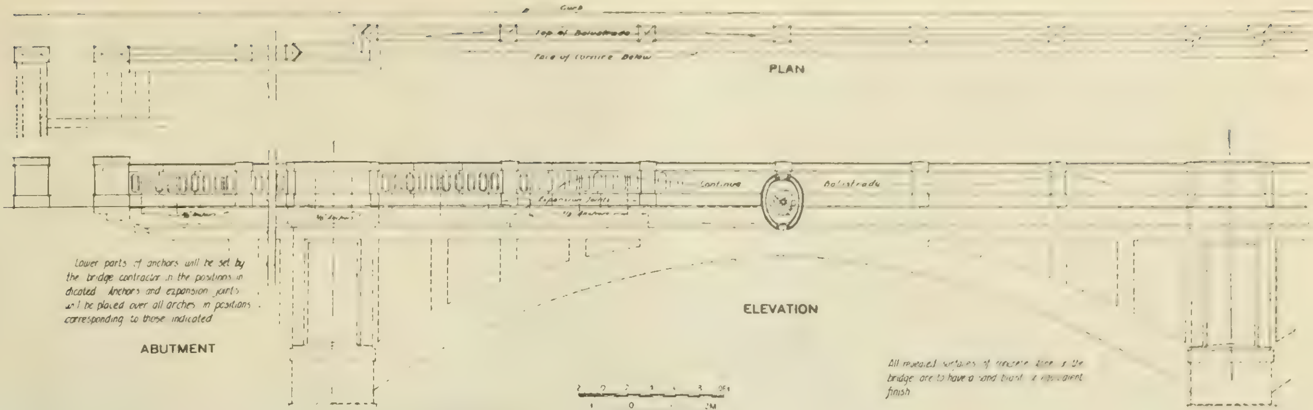

Curb
Top of Balustrade
Face of Cornice Below
PLAN
Continue
Balustrade
Expansion Joints
Anchors
Lower parts of anchors will be set by the bridge contractor in the positions indicated. Anchors and expansion joints will be placed over all arches in positions corresponding to those indicated
ABUTMENT
ELEVATION
All revealed surfaces of concrete stone of the bridge are to have a sand blast or equivalent finish
MARCH 18 1914

FIG. 19—BRIDGE BALUSTRADE, PART OF CATSKILL AQUEDUCT, OF CONCRETE STONE

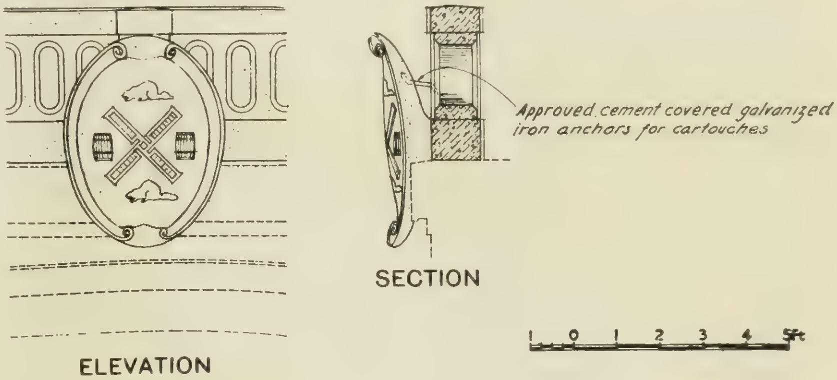

Approved cement covered galvanized iron anchors for cartouches
SECTION
ELEVATION
1 0 1 2 3 4 5Ft

FIG. 20—DETAIL OF CARTOUCHE FOR BRIDGE BALUSTRADE IN FIG. 19

ever required. Manufacturers were requested to submit large specimens for approval. Permission was also given to synthetic stone manufacturers to submit as specimens, should they desire, a small full-size section of the balustrades and parapet walls required for the Ashokan bridge. Space was acquired in Central Park near the sheep-fold where they could be erected as approved specimens of the synthetic stone for observation by prospective bidders and later serve as a useful purpose to the city. (See Fig. 1).

The contract prices for these nine buildings and bridge balustrades and cartouches was $345,535. The synthetic stone is dark, warm gray, simulating granite. Synthetic stone for one building is now delivered and the balance is being manufactured as needed by the general contractor. This work will be tooled in place when the buildings are completed. The balustrades and cartouches for the Ashokan bridge (1,260′ in length) are to have a surface finish made with a sand-blast, to harmonize more nearly with the finished surfaces of the substructure of the bridge. The concrete-stone for this work is being made by the Emerson & Norris Co.

Another contract now in progress contains 11 buildings of brick and synthetic stone similar to those previously described. The synthetic stone is being made by the Art Stone Co., Millers Falls, Mass. Synthetic stone as delivered for the first two buildings was tooled at the factory. This policy was abandoned as the advantages of tooling in place were soon apparent to the manufacturers.

We have now ready for contract bidding six large buildings near the Kensico reservoir. These buildings are to be similar in design and color to the Ashokan reservoir buildings.

From the designs shown in the illustrations from photographs and from drawings it is clear that synthetic stone was used as any natural building stone. No attempt was made to originate any new architectural style for this material, nor was one needed. The typical construction motif of today—the steel frame—is only masked, with a make-believe front, full of contradiction and pretense. Synthetic stone, reinforced, at least offers a constructive system, and its apparent form is an honest expression of its real form, whereas in natural stone there is many times no organic relation between the real and the apparent construction.

In conclusion, synthetic stone has, to the architect, the salient advantage of honestly expressing its true function as a structural member, and the further practical one of being, as well as of seeming, fireproof.

Its susceptibility to repetitive modeling places in the hands of the designer the opportunity of adding fitting detail to the good proportion and composition of a design often prohibitive in cost when executed in natural stone. The lack of this essential has robbed many designs of their potential interest and charm.

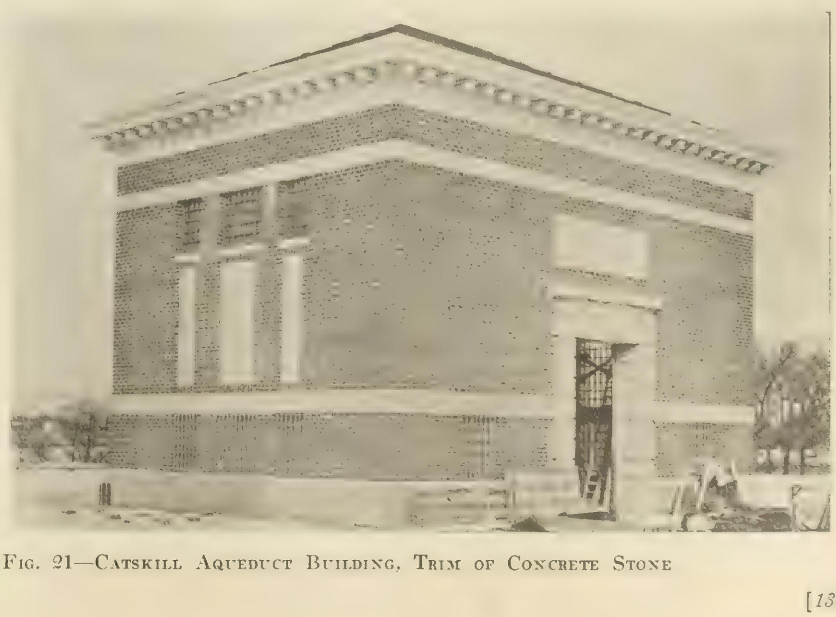


FIG. 21—CATSKILL AQUEDUCT BUILDING, TRIM OF CONCRETE STONE

Notes on Construction of the Eden Park Reservoir, Cincinnati

By K. C. Crain[1]

A concrete job which is of considerable interest in several particulars, not so much by reason of its size in the matter of the amount of material used as on account of the unusual features involved in handling the concrete, and the difficulties which had to be overcome before the actual work of placing the concrete itself began, is that of placing a waterproof lining in the west basin of the Eden Park reservoir, in Cincinnati, shown in Fig. 1. The work has been under way for nearly a year, and, after being delayed by various causes, is now nearly completed.

The extent of the surface to be concreted may be gathered from the fact that the basin is between 40′ and 50′ deep, for the most part, and has a capacity of about 50,000,000 gals.; and while the amount of concrete involved, a little over 6,200 cu. yds., is not large, as indicated above, the amount of work necessitated by the conditions of the job was such as to make the task of the contractor far from easy, as the time which has been consumed shows. While the contract was signed in June, 1913, and work begun the following July, it was expected that the work could be well completed within the time limit of 152 das., which, however, was found to be impossible. A liberal extension failed to enable the contractor to get through, and there is now a considerable over-time charge, at the contract rate of $25 a day, eating into the profits of the job.

CONCRETE LINING

The new lining, as indicated, is required for the purpose of rendering the basis waterproof, the old lining, which was also of concrete, laid in 1876, in the infancy of the art of handling that material, having proved within recent years entirely inadequate from this standpoint. Seepage caused a daily loss running as high as 2,000,000 gals. a day from the two basins comprising the reservoir, according to the estimates of the water works department of the city; and this waste called for preventive measures, which meant taking out the old lining and substituting one which would hold water.

Notwithstanding the fact that the old concrete lining had proved ineffectual, after its long service, the engineers entrusted with the task of making the basin waterproof did not permit that to bias their judgment, and therefore concrete was again selected as the most suitable material for the inside finish of the reservoir, from every standpoint. It was appreciated, however, that the tremendous quantity of water indicated would inevitably seep through the concrete, as through any other material, by its own weight, and additional waterproofing, as well as drainage through the bottom, is therefore provided.

The new lining accordingly consists of the following, the only difference between the sloping sides and the bottom being that the old concrete was removed on the sides and was left on the bottom: Grading to a proper surface (on the slopes) after the removal of the old concrete, which necessarily tore up the earth considerably, and upon the grade the placing of 6″ of crushed rock, not smaller than 1″ or larger than 3″, compacted as thoroughly as possible. Next comes the waterproofing material, which consists of a continuous sheet of asphaltic felt, furnished by the Barber Asphalt Co.[2] This material, delivered in sheets 15′ long and 4′ wide, and about ½″ thick, is joined together with a 6-in. overlap, at which pitch is applied to make a firm joint, so that, as stated, the whole is practically a continuous sheet all over the basin.

The final course is the concrete, 6″ thick, a plain mixture in the usual 1:2:4 proportion being used, applied fairly stiff and dry. No waterproofing material is used in this concrete, the felt being relied upon almost entirely, with the concrete itself, to prevent seepage. The concrete is placed in sections 15′ x 15′, held in place by plates of steel of about that length, and 6″ or 7″ wide, wired together at the ends. On the bottom the concrete is mixed with a ¼-yd. machine, operated by a 10-h.p. motor, and wheeled to place, being spread by men with shovels. A smooth surface mixture is applied in buckets and troweled to the desired finish. Tarpaulins have been regularly used when the weather required protection for the concrete.

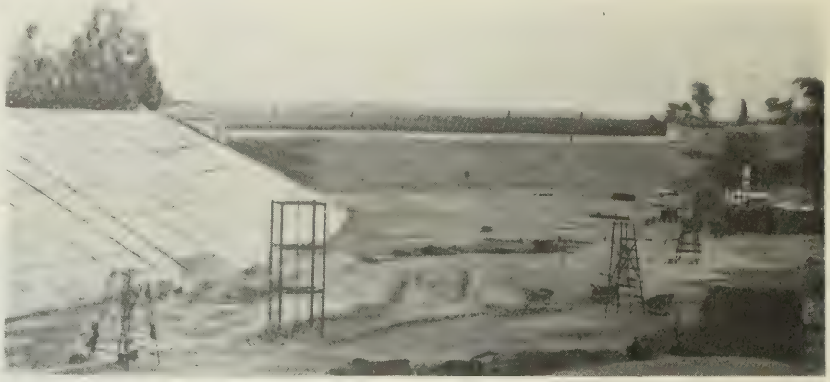


Fig. 1—General View of the Eden Park Reservoir, Cincinnati

The depth of the basin, which is about 50′, results in long slopes from the edge to the bottom, except where the dividing wall separating the west from the east section of the reservoir occurs; and these slopes, probably comprising an area about equal to that of the bottom, if not greater, offered a problem to the contractor at every stage of the work, beginning with the removal of the old concrete and continuing up to the placing of the new. If the job had been as easy throughout as the work on the bottom it is safe to say that it would have been completed well within the stipulated time limit; and the fact that it is still under way indicates accurately the difficulty which has been experienced with this part of the work.

As indicated, the removal of the old concrete offered the first, and perhaps the greatest, obstacle. At the time when it was placed in the reservoir, in 1876, it seems that concrete was not greatly trusted as a material that could be relied upon to withstand pressure, and, in consequence, the slab was made of wholly unnecessary thickness, judged by present day standards. In places it

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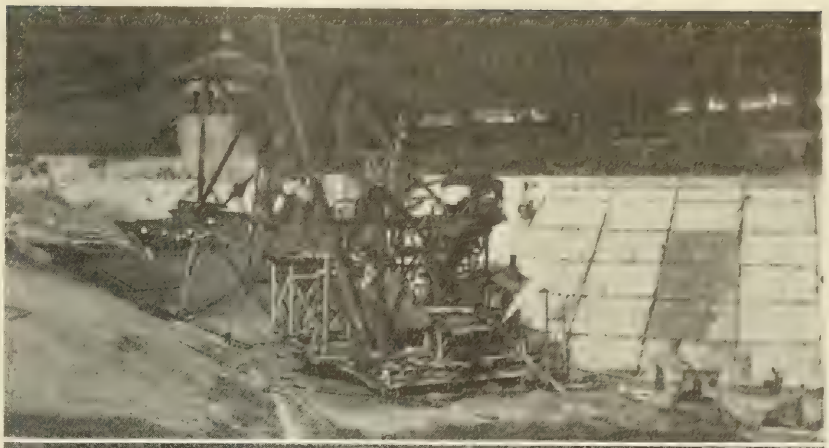
[1] Cincinnati

[2] Philadelphia



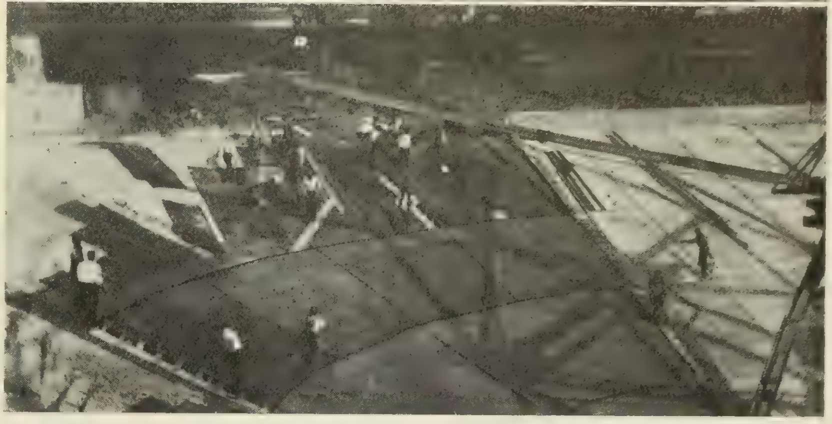


Fig. 2—Traveler in Operation, Placing Concrete on the Eden Park Reservoir

Fig. 3—Handling Concrete on the Slopes of the Eden Park Reservoir

was found to be as much as 18″ thick, and its removal was a matter requiring the use of dynamite. Holes were drilled immediately under the slab, beginning at the upper edge and proceeding downward as the material was removed, and small quantities of the explosive, half a stick and upward, exploded. This, of course, was a rather slow process, when the area to be covered is considered, and resulted in the delay indicated.

It was originally intended to remove the concrete on the bottom as well as that on the sides, and the contract called for this work. The difficulty experienced, however, together with the consideration that the old concrete would give a good surface upon which to lay the new linin, resulted in a change of plan, by which the old concrete was left in the bottom after a thorough testing by means of a heavy roller. No weak spots were discovered, and the bottom was accordingly left untouched. A corresponding deduction from the original contract price, which was in the neighborhood of $100,000, was of course made for this change.

It being impossible to work scrapers, rollers or other machinery on the sides, which slope gradually enough for a reservoir, but entirely too steeply for the use of machinery, grading had to be done, after the disturbance of the earth resulting from the use of dynamite in the removal of the old concrete, by the use of hand tools only, and this was naturally much slower than similar work on the level, with the usual equipment. In the same manner, the placing of the crushed rock and of the concrete was also much slower than in the bottom, where this work went on very rapidly.

EQUIPMENT

Complicated equipment has been used in this part of the work, the whole plant being collected on a huge traveler bearing a ½-yd. mixer and the motor which operates it (see Fig. 2), washing and screening machinery for the rock and sand used, a boom carrying a clam-shell bucket to handle material, another boom, constructed on a frame to the traveler, to handle the mixed concrete and the rock upon the slopes, and the engine operating these booms. This equipment, arranged as indicated, has been fairly satisfactory, although it is understood that the capacities of the various units was not so balanced as to enable work to proceed at all times on all parts of the equipment.

CONSTRUCTION NOTES

The old concrete, the aggregate in which was river gravel of various sizes, was crushed and used in place of crushed rock as long as it lasted, both on the bottom course and in the new concrete. When it was exhausted crushed rock hauled to the job from other points was used, and this has necessarily been the material for the greater part of the job. The procedure on the slopes has been about as follows: Grading, placing crushed rock by means of boom handling a ½-yd. bucket, distributing rock, placing felt, placing steel plate forms for concrete, placing concrete by means of boom and bucket, distributing concrete with shovels (see Fig. 3) and application of top dressing.

The clam-shell bucket lifts the material for the mixer to a hopper at the upper part of the traveler, from which point it is delivered to the mixer by chutes as needed. The mixer dumps the concrete into the bucket referred to, which is then lifted to the desired point in the slope by means of the elevated boom (see Fig. 2). Being a solid affair, the bucket has to be emptied by men with shovels, and this is naturally somewhat slow, although shovel work would have been necessary on the slopes, as elsewhere, in leveling the concrete course.

When the concrete has set the removal of the ½-in. plates which serve as forms leaves room for a pitch expansion joint which was thought desirable. The entrance of surface water, which may find its way beneath the waterproofing, as well as whatever seepage may take place from within the reservoir, is taken care of by means of 10-in. cylindrical clay drain tiles placed in the bottom of the reservoir, draining to a central outlet. It is not believed, however, that there will be any seepage worth mentioning when the new lining is completed, which should be within a short time.

Similar work will be done on the east basin of the reservoir soonor or later, and probably within a short time after the basin on which the work is now in progress is ready to receive water again after its year's vacation. The Eden Park reservoir is not now one of the essential units of the city's water systems, being intended only as a sort of second line of defense, for use in emergencies, and receiving only the surplus from the water pumped into the mains of the city. It is considered proper, however, to keep it in efficient shape as long as it is to be maintained, and the work referred to, to eliminate a heavy waste of water, resulted accordingly.

Preliminary Work in Brick Manufacture by Patients in a State Hospital

By Harvey N. Jenks, C. E.[1]

The present article contains interesting information as to why the Norfolk State Hospital, Norfolk, Mass., took up the manufacture of concrete brick, making use of its patients in the work, and it gives data as to preliminary steps taken before brick manufacture was undertaken on a rather more pretentious scale. In a second article Mr. Jenks will describe the plant built and supplied with power equipment as the second step in the enterprise.

Early in 1908 the writer was requested by Dr. I. H. Neff, Supt. of the Norfolk State Hospital, Norfolk, Mass., to make investigations as to the practicability of making concrete products as a permanent industry, depending upon the patients of the institution to furnish the necessary labor.

The first step in this investigation was an exhaustive search of the advertising pages of the various journals devoted to the interests of the concrete industry. The next step was an extensive correspondence with a number of concrete machinery manufacturers with the final result of a decision to devote the following winter to experimental work with brick. Accordingly a Miracle[2] 10-brick, hand machine and a cap and sill mold were purchased and work started in the basement of the gymnasium building, this being the only available place for conducting winter work. An excellent sandbank was found on the property, although the sand was slightly finer than is ideal for concrete, and a water test of the voids showed 31½%; it was decided, therefore, to adhere to a mixture of 1:3, notwithstanding the fact that most manufacturers recommend 1:4. The result was most gratifying and tests for absorption showed as follows:

	Weight before immersion	After 3 hrs.	After 24 hrs.	% gained 3 hrs.	% gained 24 hrs.
No. 1	93 oz.	98 oz.	100 oz.	5.375	7.52
No. 2	94 oz.	98 oz.	99 oz.	4.25	5.33

About 100,000 of these common brick were made in the winter months, and experiments were extended with colored facings and sand from various quarries, as well as waterproofing materials and white cement. The result of these experiments was in favor of our native sand, or quarried sand, coloring matter being discarded as being an added expense and not especially beautifying. Waterproofing by a special compound was deemed unnecessary in this class of work.

The accompanying table shows the added cost of materials for a ⅛-in. facing of various sands, mixed 1:2 with Portland cement at $1.20 per bbl., and with white cement at $5.00 per bbl.

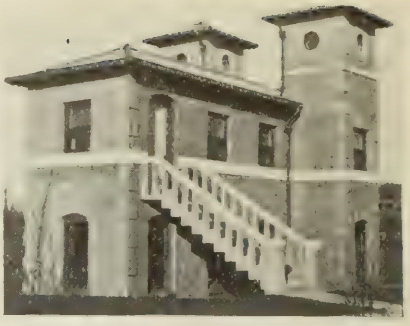


Fig. 1—Fire Department Building, Norfolk State Hospital — Built of Concrete Brick

Common brick costing $3.24 per M for cement would, after deducting the ⅜″ occupied by facing material

Table Showing Relative Cost of Facing Materials for Concrete Brick

Source of material	Based on ton lots: Cost 100 lbs. at works	Based on ton lots: Cost of freight per 100 lbs.	Based on ton lots: Total cost per 100 lbs.	White cement—$5.00 per bbl.: Cost of ⅜″ facing per 100 sq. ft.	White cement—$5.00 per bbl.: Cost of ⅜″ facing per 1,000 brick	Gray cement—$1.20 per bbl.: Cost of ⅜″ facing per 100 sq. ft.	Gray cement—$1.20 per bbl.: Cost of ⅜″ facing per 1,000 brick
Thompson Architectural Co.	$ .25	$ .19	$ .44	$2.23	$2.98	$1.23	$1.64
Ballou White Sand Co.	.17½	.42½	.60	2.56	3.41	1.56	2.08
Monarch Mining Co.	.30	.18	.48	2.30	3.07	1.31	1.75
U. S. Silica Co.	.16⅔	.42½	.59	2.54	3.39	1.54	2.05
Ottawa Silica Co.	.16⅔	.42½	.59	2.54	3.39	1.54	2.05
F. R. Upton Co.	.02½	.20	.22½	1.78	2.38	.78	1.04
Enos Adams Co.	.30	.18	.48	2.30	3.07	1.31	1.75
Crown Point Spar Co.	.37½	.15	.52½	2.40	3.20	1.41	1.88
Cheshire White Quartz Sand Co.	.22½	.18	.40½	2.14	2.85	1.16	1.55

Figs. 2 and 3—Types of Walls and Buildings Being Erected with Concrete Brick cost $2.94, plus cost of facing material as per table, equal the total cost of face brick per M for cement and imported sand, no cost account being kept of sand from our own pit or for labor and overhead charges.

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[1] Supt. Constr., Norfolk State Hospital

[2] Lansing Co., Lansing, Mich.

By the use of these various sands and by the use of a fine florist's spray nozzle while the product was still green, a variety of harmonious colors was obtained without the use of any coloring material.

In the writer's opinion a liberal use of the spray nozzle is advisable on products made by the dry process, even on common brick, especially where curing by water is practiced as it adds a considerable amount of moisture to a dry product at exactly the time it is most needed to aid in the crystallization of the cement, and should be applied immediately after the brick leave the press and be continued as long as the brick will stand in their uniform shape. A little experience will enable the operator to determine what this time should be.

After the fine spray is applied the pallets, containing 10 brick each, are racked on two supports 2″ x 6″ and 4′ long and after the initial set has taken place water is again applied with a common garden spray nozzle as often as the brick begin to show signs of becoming dry. This is continued for 1 wk., at this time they are ready to be stored out of doors even in severe winter weather. Brick, however, are not shipped or used until at least 30 das. have elapsed from the time of leaving the press.

This work was accomplished with men who not only were unskilled, but also indifferent; as the work progressed, however, interest began taking the place of indifference and finally actual pride began asserting itself in the majority of cases, allowing a relaxation of supervision.

The average daily capacity on this hand machine ranged from 1,200 to 1,500 and as our actual working time was but about 6 hrs. it will readily be seen that the machine was being run nearly to capacity.

In this experimental stage our Bd. of Trustees and our superintendent evinced a genuine, live interest in the undertaking, making frequent visits to the plant and following the reports closely, and it was largely due to their enthusiasm and co-operation that this industry with other products is on the successful basis it is today.

About this time the question arose: What shall we do with these brick, now that they are made? Can we put up buildings without mechanics? Accordingly the writer designed a small building to be used by a fire department and with a laboratory upstairs, and this was erected in the early summer, the workmen being in part the same ones who had made the brick.

In this structure the brick selected for the main body were faced with granite sand[3] and Edison[4] cement, and sprayed.

The brick at the corner piers are flush with the building line and the flush arch block at round windows were faced with a special[5] sand. The projecting brick at corner piers were faced with the granite sand and white cement,[6] sprayed. The stairs and balusters were made from native sand and Edison cement. The rails were made from white silica sand[7] and white cement, as were also the belt courses, date and name tablets. The floors were of concrete, the upper one being reinforced with No. 24 Hy-rib,[8] interior plaster on the upper floor, being applied directly to the brick work and tinted a pale green, while the roof was shingled with gray asbestos-cement shingles[9] with a light red ridge and hip roll.

It may be of interest to know that this building has not required one cent of expenditure to date, and no leakage, moisture or even dampness has asserted itself either through the walls or roof.

Before this building was completed it was decided by the Board of Trustees that this work had passed the experimental stage and the Board authorized the remodeling for a temporary products plant of the lower floor of a building which was being used as a broom factory.

The plant was hardly more than in full running condition when it was decided to move the entire institution to a new location three miles distant which assured an outlet for all of our product as the plant is operated only a few months in the winter, an abundance of outside work being at hand in good weather, laying sewers, water works, grading, farming, etc.

I have been repeatedly asked the reason for a preference for the use of brick over block or monolithic work. Possibly to the general trade there would be no preference, but as an institution we are able to make brick in cold weather when help is available and in our larger buildings which we would be unable to handle ourselves. We can furnish brick to contractors at cost, thereby reducing the cost of building in the case of monolithic work by cutting out forms, etc. In the case of block, we believe that brick lend themselves more readily to architectural design, not so many expensive machinery attachments are required, and by building walls with a 2-in. air space a continuous air space is assured, which is not true in the case of most block or monolithic structures; the necessity of constant inspection of monolithic work is also obviated.

FIGS. 4 AND 5—FACED BRICK IN WALL AND TRAP ROCK PLAIN CONCRETE BRICK IN LOOSE PILE

Concrete, after the addition of water to the mix, should be handled rapidly and in as small masses as is practical. The amount of concrete that should be placed at once depends upon the construction and kind of concrete.

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[3] Thompson Architectural Co.

[4] Edison Portland Cement Co., N. Y. C.

[5] Monarch Mining Co., Jersey City, N. J.

[6] Sandusky Portland Cement Co., Sandusky, Ohio

[7] Ballou White Sand Co., Millington, Ill.

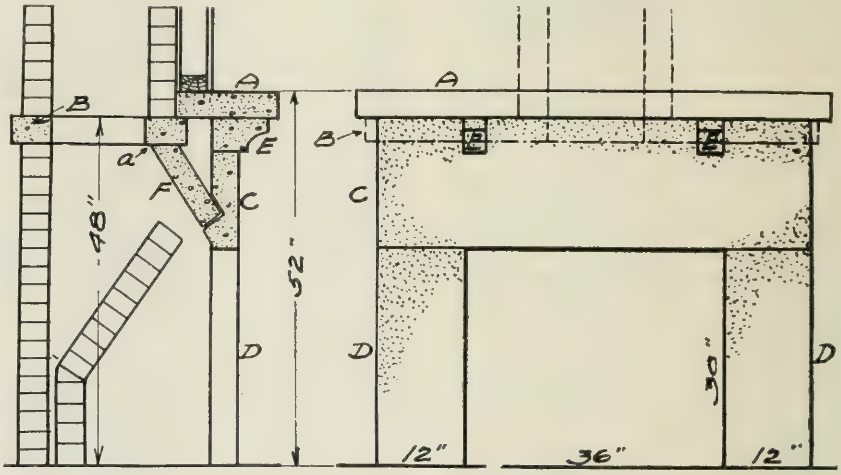
[8] Trussed Concrete Steel Co., Youngstown, Ohio

[9] Keasby & Mattison Co., Ambler, Pa.

Concrete Mantel Made With Pre-Cast Units

A unique shell-faced concrete mantel, shown in Fig. 1, was recently constructed in a club house at Georgiana, Fla. The face of the mantel is 12″ from the wall, the opening 2′ 11″ x 4′ 6″, the height of the shelf 4′ 8″ and the mantel 9′ long. The mantel was made in reinforced concrete slab units 3¾″ thick, consisting of 2 ends, 2 jambs and 1 arch slab. The curved top row of brick projecting beyond the face of the mantel was made in short lengths and the shelf cast in place. The shelf, hearth and border around the opening were colored red. The construction features may be more fully described as follows:

A level platform, made of flooring with 2 x 4's for side forms, was used. Small wooden strips ¼″ x ⅜″, slightly beveled, were fastened in place on the platform by nails driven at the sides for the purpose of giving the appearance of brick construction to the mantel. The face of the platform was covered to a depth of ¼″ with small, washed beach shell. A wet mortar, consisting of 1 part Portland cement to 2 parts sand with some shell in it, was then deposited in the forms to the depth of about ¾″ and well pressed down in order to embed the face shell. The mixture for the rest of the slab consisted of 1 part Portland cement to 3 parts sand with a small amount of shell in it. While the mortar facing was being applied a piece of tin was put in close to the form and shell put in behind. After the mortar had become filled up, the tin was removed and mortar pressed well back. The outer corners were dove-tailed to fit the end slabs. The shelf was made of 1 part Portland cement, 1 part sand and 2 parts shell. Red coloring matter was used as facing. After the shelf had cured for about two weeks it was rubbed down with a carborundum brick, giving a smooth surface and exposing the shell. The joints were pointed with red mortar to correspond with the shelf and hearth. Six sacks of cement were used in this mantel, and while the cost was not kept separate, the mantel set up cost approximately $35.



Figs. 2—Details of a Plain Shell-Faced Concrete Mantel

The same style of shell-faced mantel, made as above with the exception of the brick effect, is shown in Fig. 2. The slab units of the sizes stated above could be put up for about $15 under average conditions.

Fig. 2 shows the layout of the platform used in molding the several slab units. The back slab *B* is cast with an opening corresponding to the size of the flue and a groove made on the under side near the edge to form a drip to prevent water entering the fire place. This may be done by putting a small strip in position on the platform or cutting the slab with a chisel before placing. The fire-back must be placed forward enough so that any water coming down will strike on the back side as shown in Fig. 2.

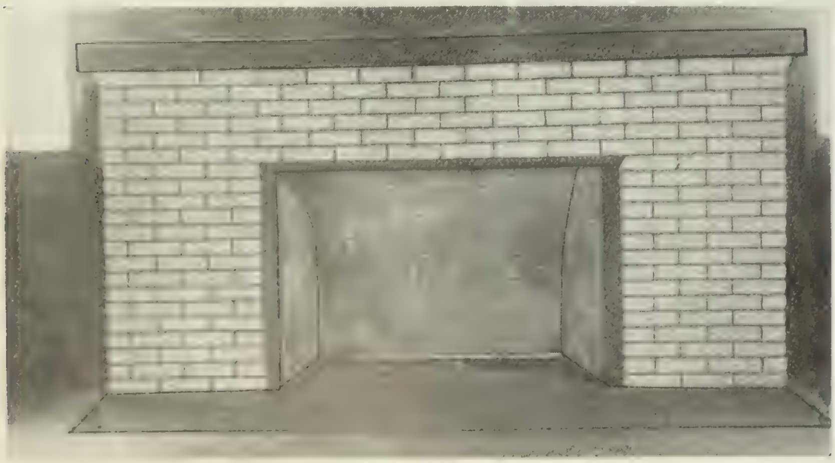


Fig. 1—A Shell-Faced Concrete Mantel with Brick Effect, at Georgiana, Fla.

When the chimney is placed in another room or outside of the house on a porch, the slab *B* forms a much better construction than the old way of raking back the brick. In a kitchen it makes a useful shelf, and on the porch a place for flower-pots. Enough brick are saved to more than pay for the construction of this slab.

Slab *F* is made about 1 ft. larger than the opening and fits in a depression made in the back of slab *C*. It is also backed up by brick built up from the sides of the fireplace lining.

The joints of this mantel may be pointed up with colored mortar or with ordinary cement mortar, and shell thrown on and pressed in to correspond with the face.

A. W. Devol, Cocoa, Fla., was the contractor. He has built several of these mantels at a very economical cost.

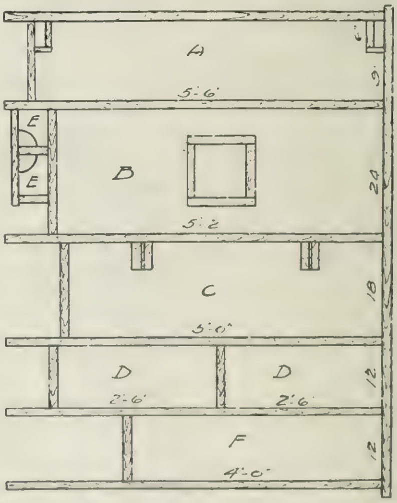


Fig. 3—Molds Used in Constructing Concrete Mantel Shown in Fig. 2

Piles or heaps of broken stone having admixture of dirt or considerable fine dust should be rejected and not allowed to enter any concrete work whatever.

Advantages in Use of Commercially Hydrated Lime Over Ordinary Slacked Lime

By E. W. Lazell, Ph. D.[1]

Slaking Lime.—Every one is familiar with the fact that when quicklime is treated with water a violent action takes place, the lumps of lime break up, heat is generated, steam is given off and after the action is completed, a paste or putty remains—the ordinary lime putty used for mortar. The fact that quicklime has changed its form from dry lumps to a wet paste and that heat has been generated prove that a chemical reaction has taken place; or that quicklime has combined chemically with water. It is a scientific fact what any chemical change or reaction occurs exact amounts of the material are involved. In the chemical change which takes place when lime is quenched with water definite amounts of lime and water are involved; in slaking lime an exact amount of lime unites with an exact quantity of water, forming an exact amount of hydrated lime. If after the slaking only sufficient water is present to satisdry powder will remain. This powfy the calcium oxide (lime) then a der is hydrated lime and it differs from the original quicklime and from pulverized lime in its behavior towards water. When water is added to hydrated lime no heat is generated nor does the material slake, thus indicating that water has no further chemical action on the hydrate.

What is Hydrated Lime?—Hydrated lime of commerce is the dry powder resulting from the treatment of lime with sufficient water to satisfy the chemical requirements of all the calcium oxide.

Necessity for Exact Proportions of Lime and Water.—In the foregoing, emphasis has been laid upon the fact that precise amounts of lime and water react chemically. In other words, 1 lb. of lime requires a certain definite amount of water to form a perfect hydrate. If too little water is used in quenching the lime in the process of manufacture the lime will be burned in slaking and free lime, or lime which is not combined with water, will be present in the hydrate, rendering the material unsound. Plaster made from such hydrated lime will later pop and pit, due to the gradual slaking of the free lime by the moisture present in the atmosphere. Further, mortar made from such unsound hydrate generally works tough and non-plastic. The free, uncombined lime when present to any considerable extent will dry out the mortar, rapidly decreasing its strength and causing it to crumble. Free lime in hydrated lime is a dangerous ingredient and one which will always give trouble.

If too much water is used in the preparation of hydrate the material will be damp and wet, rendering it difficult to handle.

Obsolete Methods of Manufacture.—In the past, three methods were used to produce hydrated lime:

(1) Small pieces of lime were were placed in a basket and immersed in water for a few minutes, until slaking began, when they were withdrawn and placed in a heap in order to conserve the heat and prevent the escape of the vapor; the maatrial swelled, cracked and became reduced to a dry powder.

(2) Lumps of lime were placed in a heap and wet at intervals until the mass was equally moistened throughout. The slaking proceeded as in the first instance.

(3) Small pieces of lime were exposed to the air for a number of months and the lime absorbed both water and carbon dioxide from the atmosphere, falling to a dry powder. The powder consisted of dry sub-carbonate of lime containing about 10% to 11% of water.

These three methods of dry-slaking lime were crude and unless the greatest care was exercised, the resulting product contained particles of unslaked lime. The hydrate produced by these methods was generally short and possessed poor sand-carrying capacity; in fact, hydrated lime made by any of the above methods was suitable for use in agriculture only and such hydrate should not be confounded with hydrated lime manufactured by modern methods.

Modern Methods of Manufacture.—The modern method of manufacturing hydrate depends upon the addition of a definite amount of water to a predetermined amount of lime. By no other method is it possible to produce a hydrate which will contain sufficient combined water to satisfy the demands of the calcium oxide (lime) present. It is of the utmost importance that all the calcium oxide be in combination with water, otherwise the hydrate will be unsound and unsuitable for building uses. That all the lime be satisfied with water will be insisted upon in any specifications which may be drawn for hydrated lime to be used in the building trade, and it is vital for each manufacturer to recognize that the formation of hydrated lime involves a chemical change requiring the presence of exact amounts of lime and water. Since the process is chemical, it requires the same careful supervision as any other chemical process, such as the manufacture of Portland cement. The production and use of hydrated lime have been more retarded by the manufacture of only partly hydrated lime than from all other causes. Any method of manufacturing hydrated lime continually to produce a perfect product must be based upon weighing the lime used and measuring the amount of water added.

ADVANTAGES OF HYDRATED LIME

(1) *From the Standpoint of the Manufacturer.*—One of the great diffculties in connection with the manufacture of lime is the perishable quality of the product. Lump lime cannot be stored for any length of time without deterioration, thus making the operation of the plant dependent upon the season and the whims of the weather. Kilns must be fired up, damped down or put out, according to the season of the year and the condition of the weather. This unevenness of operation results in a high unit cost. Since hydrated lime can be stored in bins in a manner similar to cement, it is possible to make the operation of the plant more nearly continuous, thereby introducing economies in the manufacture and reducing the cost. The manufacture of hydrate also means a more extended market, as hydrated lime can be used for a number of purposes for which quicklime is not suitable.

(2) *Advantages to the Dealer.*—Three principal advantages to the dealer are the ease in handling, less deterioration of the product and the freedom from fire risk. These three facts alone should convince the dealer that it is more economical to handle hydrated lime.

(3) *Uses of Hydrated Lime.*—In general it may be stated that hydrated lime is suitable for any use in the building trade to which lump lime can be put, and it would appear that as soon as the material comes into general use, its advantages will be found to far outweigh any disad-

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[1] Chem. Engr., Portland, Ore.

vantages. The use of hydrated lime does away with the necessity of slaking lime to a paste, thus saving the space required for the slaking bed as well as the labor of slaking. By the use of hydrate it is possible to proportion the mortar so as to have exact quantities present, since this form of lime comes into the market in convenient packages of known weight. This point is always appreciated by the architect and engineer, as it is a well known fact when lump lime is used, as much sand as possible is added with the result that the mortar is lean and possesses little strength. If hydrated lime is correctly manufactured and the particles of core removed by some process of separation, the resulting product will possess a higher grade of purity than the original lime from which it is made. The product will also be more uniform and these two facts appeal strongly to all users of lime.

Mortar made from Hydrate is Stronger than that made from Slaked Lime.—In June, 1910, the writer presented the results obtained from an extended series of tests on mortars made from both hydrated lime and lump lime to the Am. Soc. for Test. Mat. One of the most important conclusions drawn from these investigations was that the mortar produced from hydrated lime was stronger than that produced from the corresponding lump lime slaked to a paste. This conclusion was to be expected, since it is possible to manufacture hydrated lime by mechanical means under good chemical control, which is more thoroughly slaked than it is possible to slake lump lime on the job. With lump lime, the user is always dependent upon the thoroughness of slaking, and it is well known that unless lime paste is run off and stored for some considerable time, there is no assurance of complete and thorough slaking.

Practically all those who have investigated the strength of lime mortars have recommended the use of hydrated lime in place of lump lime. In Bulletin No. 30 of the Bur. of Standards, the following statement is made: "The proportion of impurities in hydrated lime is generally less than in the lime from which it is made. In building operations hydrated lime may be used for any purpose in place of lump lime, with precisely similar results. The consumer must pay the freight on a large amount of water, but the time and labor required for the slaking are eliminated and there is no danger of spoiling it either by burning or incomplete slaking * * * * For all building purposes hydrated lime is to be preferred to lump lime. By its use the time and labor involved in slaking may be saved and the experience of the laborer is eliminated as a factor in the problem."

If the use of hydrated lime in the building trade is to be increased, this can be brought about only by the manufacturers of hydrate preparing and marketing only such material as is sound and contains no free lime. There is an increasing demand for hydrate for use in concrete to render the material more plastic and dense. Hydrated lime can be advantageously used in all cement plaster and stucco to make them work smoothly and give a more pleasing color. In all these uses the soundness of the hydrate is the paramount requirement. No one would think of using unsound cement —why then, should they expect to use unsound hydrate?

The market for hydrated lime is present and a concerted action on the part of the lime manufacturers to exercise the care necessary to make a thoroughly hydrated lime will result in a more extended use of the material. It is to be hoped that the manufacturers will direct their energies along this line.

B. F. Affleck Succeeds Edward M. Hagar as Cement Co. Head

Edward M. Hagar has resigned as president of the Universal Portland Cement Co., and B. F. Affleck has been chosen to succeed him. Announcements of Mr. Hagars' resignation and Mr. Affleck's election were made Feb. 4 and 5.

Mr. Hagar was head of the Universal Company for 15 yrs. and manufactured the first barrel of cement in May, 1900. The company's business has grown from 32,000 bbls. produced in 1900, to its present capacity of approximately 12,000,000 bbls. per yr. Mr. Hagar was for two yrs. president of the Assn. of Am. Portland Cement Mfrs. and is an important factor in the promotion and development of the use of cement in building construction of all kinds. He also founded the Cement Products Exhibition Co., in 1907. This company conducts the annual Cement Shows. The Mass. Inst. of Tech. and Cornell Univ. both claim Mr. Hagar as an alumnus. He was graduated from the former in 1893 and received a post-graduate degree from Cornell in 1894. Before becoming connected with the cement industry, he organized and conducted the business of Edward M. Hagar & Co., in Chicago, acting as sales representatives for machinery manufacturers. Mr. Hagar retires to assume the presidency of a new company which he is forming to acquire a chain of Portland cement plants covering a large part of the U. S. The headquarters of the new company will be in Chicago.

Mr. Affleck entered the service of the Illinois Steel Co. in 1896 and from 1901 to 1903 represented the cement department of the company in the St. Louis territory. When the Universal Portland Cement Co. was incorporated in 1906 to take over the cement business of the Illinois Steel Co. he became general sales agent, playing an important part in the growth of the business. He is vice-president of the Cement Products Exhibition Co., under whose management the annual Cement Shows have been held in Chicago. He is recognized as a pioneer in promoting the use of concrete as a paving material.

Officers of the American Roadbuilders' Assn.

George W. Tillson, cons. engr. for the president of the Borough of Brooklyn, N. Y. C., has been elected president of The Am. Road Builders' Assn. Other executive officers for 1915 were elected as follows: 1st vice-pres., A. W. Dean, chf. engr. of the Mass. Highway Comm.; 2nd vice-pres., Austin B. Fletcher, state highway engr. of Cal.; third vice-pres., S. Percy Hooker, state supt. of highways of N. H.; secy., W. L. Powers, editor *Good Roads;* treasurer, Maj. W. W. Crosby, consult. engr., Baltimore. In addition, the following were elected directors for three yrs.: E. A. Fisher, city engr., Rochester, N. Y.; A. R. Hirst, state highway engr., Wis.; Joseph W. Hunter, first dep. commr., Pa.; state highway dept.; Frank F. Rogers, state highway commr., Mich.; William R. Smith, gen. mgr. of the Lane Constr. Corp., Meriden, Conn., and H. M. Waite, city mgr., Dayton, Ohio.

A Correction

Lee A. Hoynck, author of an article on "Methods and Costs in Constructing Factory Building at Houston, Tex.," published in our Feb. issue, calls our attention to an error on page 60, which consisted in crediting the Texas Portland Cement Co., Dallas, Tex., with having supplied the cement, whereas Trinity cement was furnished by the Southwestern States Portland Cement Co., Dallas, Tex.

Annual Convention American Concrete Pipe Association, Chicago, Feb. 15-16

The American Concrete Pipe Assn. held its convention in Chicago, Auditorium Hotel, Feb. 15 and 16, 1915, and several excellent papers were presented before it. Of most consequence, however, to the future of the organization and the increasingly important industry which it represents is the step which has been taken by its Resolutions Committee looking to a reorganization of the Association on a more aggressive basis. This action is outlined in resolutions adopted as follows:

> Whereas, we believe that the interests of the Am. Concrete Pipe Assn. demand that a larger amount of work shall be done to promote the use of cement pipe and tile, and promote the interests of the manufacturers of these products; and
>
> Whereas, we believe this can be done only by getting a large number of the members actively at work for the interests of the organization and the industry as a whole; therefore be it
>
> Resolved, That the American Concrete Pipe Assn. at this present convention elect a committee of five to be known as a Reorganization Committee, the duties of this committee to be to submit a form of reorganization to cover the broader activities which should be taken up.
>
> Resolved, That in particular, this committee shall revise the Constitution and By-Laws of the Association, so that they shall provide for a number of standing committees which shall be at work throughout the year, the Reorganization Committee after due consideration to suggest such committees as in its opinion should be provided for.
>
> Resolved, That this Reorganization Committee submit a report to the members not less than 90 days before the next annual meeting, outlining the plan which the committee has adopted and presenting for consideration the revised Constitution and By-Laws.
>
> Resolved, That the president appoint a membership committee of five members to serve during the present year, for the purpose of devising and executing plans for presenting the value and benefit derived from active connection with the American Concrete Pipe Assn. to pipe and tile manufacturers throughout the U. S., this committee being empowered to use any means thought advisable for this purpose.
>
> Resolved, That the thanks of the Association be extended to the speakers who have presented such valuable papers at this convention, and to all those who have so efficiently assisted to make this meeting a success. E. S. Hanson, chairman, G. F. Lillie, J. H. Libberton.

President B. Blair, Woodstock, Ont., was called home by illness in his family, after reaching Chicago so Vice-president Hammond presided.

J. J. Commons[1] presented a paper on "Advertising and Sales Promotion for Pipe and Tile Manufacturers," basing his remarks on replies from 300 letters he had sent to manufacturers in the Middle West. This paper will be published in a later issue of this magazine.

"Reinforced Concrete Tile," a paper by W. J. Schleck,[2] which will be presented in a later issue of this magazine, reported tests made recently at the plant of P. H. Atwood, Armstrong, Ia.

J. H. Schmeltzer[3] told why in 30 years of drainage work he has come to prefer concrete pipe.

Lewis R. Ferguson[4] presented a paper on concrete sewer pipe, covering investigations of concretee sewers which he has made in all parts of the country.

John L. Zeidler[5] discussed freight rates and shipping conditions affecting the concrete pipe industry.

P. W. King[6] presented a paper describing the possibilities in the use of bulk cement by pipe and tile manufacturers.

Charles P. Stivers[7] presented an illustrated paper on "Concrete Pipe for Railroad Culverts."

An important action of the Convention was in the adoption of the Standard specifications for Drain Tile of the Am. Soc. for Test. Mat.

The annual dinner of the Association, the evening of Feb. 15, was an enjoyable get-together occasion.

The remarkable success attending the flotation of the $49,000,000 4½% loan of the Pennsylvania Railroad, which, according to best reports, was more than five times oversubscribed, points the line of municipal improvements which should be prosecuted at this time.

At the end of a cycle of good times there comes a period when the savings of the people and the prostration of ordinary business and industry bring about a period of cheap money and of unemployment for the laboring man. It is at this time in the cycle of years that those who have charge of the city, county and municipal improvements should bestir themselves to take advantage of the low money conditions and find employment for the idle workmen within their borders. All through our country new roads, new sewers, new bridges and new water plants are needed and improvements on the old are equally necessary. No time like the present has existed in many years for public work to be economically done, both with relation to the rates of wages and the rates for money and it is hoped that the occasion will not be permitted to pass without its being availed of for the construction of these many important and necessary works.

And now concrete appears as a cure for rats—not taken internally, but externally. In a recent pamphlet calling attention to the dangers and destructive characteristics of the rat and urging citizens to take measures to get rid of these nuisances, Dr. Richard Harte, dir. of the Dept. of Pub. Health of Philadelphia, says that the most satisfactory method of getting rid of these disseminators of disease is not to attempt to trap or poison them, but to "build them out of existence." He says:

> This is best done by the use of concrete or cement in all construction work. Old cellars may be made rat-proof at comparatively small expense by the judicious use of cement. Rat holes may be permanently closed with a mixture of cement, sand and broken glass or sharp bits of crockery or stone. The principle is to allow no opening or crevice of any kind within which rats may nest or find protection from their natural enemies.
>
> The concreting of basements and the removal of plank sidewalks and the replacement thereof with concrete have the additional advantage of excluding dampness from the house and contributing to the general cleanliness and sanitary conditions of the premises.

The most recent Italian earthquake, with its record of 35,000 people killed and 45,000 injured, carries its lesson so far as construction is concerned. Newspaper specials from Rome agree that the great mortality is attributable to the method of dry construction employed in the affected region, the stones being piled upon each other without mortar. The only buildings which escape total destruction were the modern houses, built of reinforced concrete.

Messina, the destruction of which is in the minds of all of us, has already profited by her experience and most of the new houses in that city are of concrete.

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[1] Chicago Portland Cement Co., Chicago

[2] Drainage Engr., Iowa Experiment Station

[3] Drainage Engr., Manteno, Ill.

[4] Asst. Secy., Assn. Am. Portland Cement Mfrs.

[5] St. Joseph, Mo.

[6] Universal Portland Cement Co., Chicago

[7] Assoc. Editor, *The Contractor, Chicago*

Field Methods in Concrete Construction—Design and Construction of Forms in General

By Jerome Cochran, C. E.

This is the third of a series of articles on field methods in concrete construction, the first of which pertained to the selection of concrete materials, and the second to the proportioning and mixing of concrete, published in this magazine for Jan., 1915, and Feb., 1915, respectively. The present article will consider briefly the design of forms, which should be considered as a structural engineering problem. The subject will be continued in the next article. The design and construction of concrete form work have been seldom, if ever, properly presented, the majority of writers being content to give examples without comment or suggestion.

Readers of Concrete-Cement Age *are invited to discuss points they consider to be inadequately treated in the present article or in future articles, to the end that the subject may be properly presented. Contributions and criticisms will be welcomed and for clearness they should be accompanied when possible by drawings or photographs. When patented methods are mentioned, always give name of owner and date of patent.*

SUPERVISION OF FORM CONSTRUCTION

In the erection of reinforced concrete work nothing requires more careful consideration than the construction of the form work, or molds, necessary to shape and support the concrete until it has thoroughly hardened, as the safety of the structure may be jeopardized by faulty form construction. Wooden forms, as frequently erected for such work, upon careful inspection show a great many weaknesses and inadequacies, and the factor of safety which exists is surprisingly low. Not long ago a building collapsed with the centering still in place. The claim was made that some blasting was done which shook the structure so much that it collapsed. That was a very clear indication that the centering was erected in an extraordinarily lax manner. Too often the design of forms is left entirely to the contractor, whereas it should be recognized as part of the work of the designer of the structure. Architects and engineers have been prone to work on the supposition that if the specifications require a certain standard of work when finished, the contractor will use his best efforts to secure this result, regardless of the fact that the contractor usually takes greater chances during the construction than are always good for the work.

Various methods of form construction are used in reinforced concrete work, and, where no design is furnished the contractor, he should be allowed to use such type of forms as he may desire, if, in the opinion of the engineer, the proper results will be obtained. If, however, it is apparent that the forms are not properly constructed so as to give the desired results, the contractor should be required to make such changes as the engineer may deem necessary to give satisfactory results.

Plans and details for forms, if required to be furnished by the contractor, should be submitted to the engineer for his approval before starting the form work, but such approval should not release the contractor from any responsibility for the safety of his work and the work of other contractors.

DESIGN OF FORMS IN GENERAL

Rules for designing concrete forms are difficult to deduce as every structure has its own peculiarities; the amount of concrete deposited in the form, if wet, or dry, if deposited by hand-mixing or machine-mixing from a board or from dump buckets, all influence the design. Forms have been built which were perfectly safe with a dry mixture shoveled off a board, but which needed rebracing when the concrete was wet and was dumped from buckets.

The dead load on forms should consist of the calculated weight of the forms and the concrete, the liquid concrete being assumed to weigh 150 lbs. per cu. ft. It is usually reqired that forms be so designed and constructed as to carry four times the dead load of the concrete and the steel reinforcement.

The live load on forms should be taken at 75 lbs. per sq. ft. upon slabs and 50 lbs. per sq. ft. in figuring beam and girder forms and struts.

Forms should be designed to withstand safely a wind pressure of 20 lbs. per sq. ft., upon all surfaces exposed to the wind.

In proportioning forms, concrete should be treated as a liquid of its full weight for vertical loads and one-half its weight for horizontal pressures.

The allowable compression in timber struts should be from 600 lbs. to 1,200 lbs. per sq. in., varying with the ratio of the size of the strut to length. Extreme transverse fibre partial rupture of the concrete or sagging of the beam. Flank joists and timber beams may be computed by the following formula, allowing a maximum deflection of 1/8″:

$$d=\frac{3}{384}\;\frac{Wl^3}{EI} \qquad (1)$$

and

$$I=\frac{bh^3}{12} \qquad (2)$$

in which

d=Greatest deflection in inches
W=Total load on plank or joist in lbs.
l=Distance between supports in ins.
E=Modulus of elasticity of lumber used
I=Moment of inertia of cross-section of plank or joist
b=Breadth of lumber
h=Depth of lumber.

For spruce lumber and other woods commonly used in form construction, E may be assumed as 1,300,000 lbs. per sq. in.

Formula (1) may be solved for I, from which the size of joist required may be readily estimated from formula (2).

ECONOMY OF FORM CONSTRUCTION

Forms should be constructed with a view to economy in taking down rather than cheapness in erecting or in first cost. With a little ingenuity and forethought, forms can almost always be arranged so that repeated use is made of each piece of lumber. It is not unusual to construct a 10-story building by using over again the form work for the first three stories. It frequently requires a great deal of study to design the forms so that they can be so used, but it means a great deal of money in the contractor's pocket.

In many instances forms may be used several times with slight modifications in size from story to story or from bay to bay, resulting in the greatest economy in material and labor. The design of the structure should always go hand in hand with the design of the forms. Sometimes heavier sections may be used with form work in view than would be strictly correct for economic design, as the saving of a thin layer of concrete may enormously increase form costs.

Forms should be designed with a view to obtaining as much economy as possible in labor and cost of material. Too much attention paid to economy in material is apt to run up the labor cost, resulting in a dead loss. On the other hand, if the cost of material is run up it is not all loss, for much of the lumber has a salvage value, especially where attempts are made to hold as much as possible to standard lengths of lumber. Therefore it pays to have all forms designed in the office as carefully as other details are designed.

LUMBER FOR FORMS

Regarding the size, thickness and quality of the lumber used for forms, custom differs with designers and localities. In fact, designers differ greatly in their ideas of the proper thickness of lumber to use for various parts of form work. The thickness must be such that the lumber will not deflect, bulge or warp under the loads imposed upon it.

The design should not call for very wide boards, for the reason that they curl and split badly. Amply thick and heavy material should be used for forms, especially if they are to be used a number of times. Thinner material is easily broken, thus requiring more labor for repairs than would pay for the extra thickness.

Generally speaking, 1-in. stuff is used for floor lagging with joists spaced up to 24″ or when built into panels; for columns and wall lagging 1¼-in. to 2-in. stuff is used; for sides of beams and girders 1-in., 1¼-in., 1½-in. and 2-in. stuff is used; and for bottoms of beams and girders 1½-in. and 2-in. stuff.

The shores and supports for the usual floor forms generally consist of rough 4-in. x 4-in. studding, it having been found by practice that such studs, when placed from 4′ to 6′ o. c. possess the strength necessary to carry the weight of the wet concrete. For ledger boards, cross-braces and ties, as well as for nailing strips and battens, 1-in. x 6-in. or 1½-in. x 6-in. boards are found convenient; 2-in. x 6-in. and 3-in. x 6-in. joists are used to some extent for the support of slab centering and for the bracing of the uprights. These dimensions are by no means invariable, as a study of the numerous examples of actual form work given in CONCRETE-CEMENT AGE, and many books on plain and reinforced concrete construction, will show. Timbers as large as 4-in. x 6-in., 6-in. x 8-in., and 8-in. x 10-in. are used to brace and secure the form work for heavy concrete wall and buttress construction, and all sizes are used for falsework of concrete arch construction.

Dressed lumber should be used where a finished surface is desired, and undressed lumber for backing and other rough work. T. and g. boards are more expensive than boards surfaced on one side and the edges, and they are particularly hard to place a second time. Smooth boards will reduce the labor of removing and cleaning the forms.

USE OF NAILS AND WIRE TIES

Forms should be constructed in such a way as to avoid the use of nails, whenever possible, as unnecessary nailing not only calls for more nails, but adds to the difficulty of removing and the danger of splitting and ruining the boards. This is a primary rule to observe in the design and construction of forms if possible and it will pay to study this point carefully on every design. Make cleats, wedges or other clamping devices do as much work as possible in preference to nails, spikes and screws.

Avoid the use of wire also when it is proposed as a substitute for nails, if it can be done. Wire ties, however, may be used to secure forms against pulling apart, being wound around opposite studs and the twisted with a stick, as a turnbuckle, until the studs are the proper distance apart. The use of wire ties will be discussed more fully in another article under "Wall Forms."

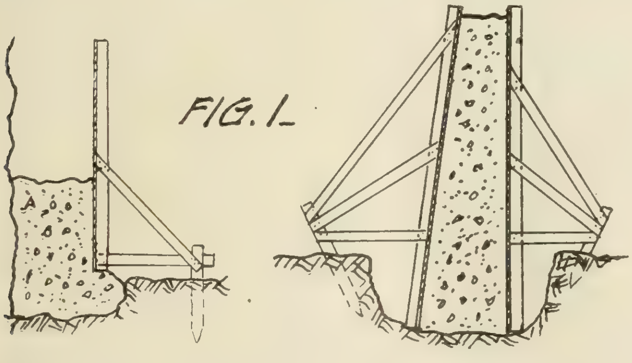
Sections to be used over and over must be securely nailed, while forms to be taken apart should have as few nails as possible. Boards and planks usually need but few nails unless the forms are built so that pressure tends to separate them from the cleats. The pressure of concrete will generally hold temporary panel boards in place with very few nails. The sheathing of wall forms, for instance, if to be removed board by board, requires only enough nails to take out the wind of the boards and hold their own weight till the concrete is placed.

An excellent illustration of the villainous nail-using vice in all its hideousness, the device of green men and unpractical men, is shown in Fig. 1.

BRACING OF FORMS

Forms must be securely braced or tied together to withstand the loads that come upon them and preserve their alignment, so that the pressure of the concrete, or the movement of men, machinery or materials, will not throw them out of place. They should be of sufficient rigidity that the vibrations may not be severe enough to affect the setting of the cement. Rigidity is as important as strength, and deflections of forms should be limited to very small amounts. In calculating forms, particular attention must be paid to deflection even more than strength.

Forms may be braced (1) with



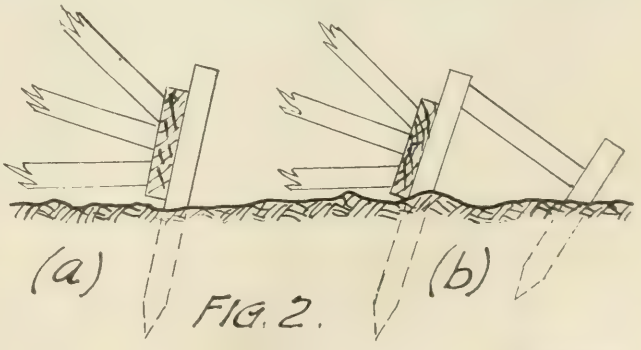


FIG. 1—COMMON DETAILS USED IN BRACING FORMS WITH SIDE NAILED BRACES
FIG. 2—PROPER METHODS OF ABUTTING BRACES AND POSTS IN ORDINARY AND SOFT GROUND

These details illustrate common forms of connection for the lower and upper end of braces, which may be considered bad examples of bracing

Fig 2a shows how the braces should abut against posts driven in the ground, while Fig. 2b shows how the posts themselves are braced if the ground is soft outside inclined braces, leaving the interior of the form unobstructed; (2) tie-rods across the interior of the form, connecting opposite posts at frequent intervals; (3) each post trussed vertically and tied across at top and bottom only; and (4) horizontal trussed walls outside of posts, spaced from 4′ to 6′ apart in the vertical and tied across at the ends.

If thin inclined braces are employed they should be in pairs, one on either side of the vertical post, and made to act together by crosspieces nailed to the two planks. Braces must be designed to resist all tendency to slide, and may be useless if put in without thought.

Very common details in bracing forms are shown in Fig. 1, the objection being to the loosening of the post by the driving of the nails, the splitting of both braces and post by the manner in which the strain comes on them, the loss of time in driving and afterwards drawing the nails and also the waste of material involved.

Strange to say these and other wretched details in constructing form braces are still presented in semi-technical publications, and in advertising books issued by firms that ought to be in a position to employ the best talent in preparing them for publication. The worst of it is that such examples as those given in Fig. 1 are apt to be reproduced in publications intended to be educational or in popular magazines and papers from which the public obtains nearly all information on technical subjects. This leads one to suspect that the men employed to compile such books are men whose knowledge of form construction is academic rather than practical, and who are prone to follow printed examples, most of which are very old and many prepared by men who have had no experience whatever in breaking the men to the work of making and using forms. In such books it certainly seems best to get the opinion of really practical men on details of work before preparing the illustrations.

In Fig. 1 the post is driven to hold the braces firm and after the post has been driven until it shows signs of splitting, braces are spiked to it, which frequently require hard driving to get spikes through them into the post (especially with 2-in. lumber). This loosens the hold in the earth, increases the size of the cracks and completes the destruction of the post. The strain on the brace is apt to be somewhat eccentric due to not being in a direct line with its center, thus increasing the splitting tendency. The pressure carried by the nail is transmitted across the grain of the post and braces.

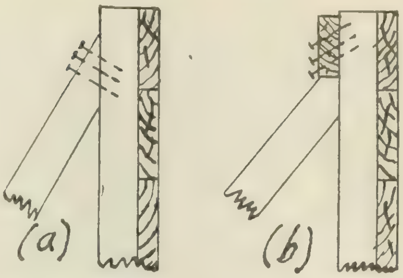


Fig. 3—Sketch Showing Improper and Proper Connections for Braces

Fig. 3a shows a method used very often at the upper end of a brace when the side nailing plan has been abandoned, while Fig. 3b shows the only method that should be followed

Another comment or objection might be made to the connection for the upper end of the brace against the forms shown in Fig. 1. Here the driving of nails tends to move the forms and no adjustment is possible.

Such illustrations of poor bracing as shown in Fig. 1 are seldom seen in actual practice where the man in charge of form work is experienced. Even very ordinary carpenters laugh at them.

When braces are placed against the post in the manner shown in Fig. 2, the smallest movement may be caught and the form stiffened before damage can be done. The posts themselves may be braced as shown in Fig. 2, where the ground is soft. A stiff support against which braces may be placed at any point may be had by driving a line of posts and laying against them a heavy timber or thick plank. Immediate braces may be quickly introduced if the forms show any sign of giving way, thus avoiding delay caused by driving new posts.

The method of fastening the upper end of the brace shown in Fig. 3 (a), where the side nailing plan previously commented upon has been abandoned, is open to the objection that the thin end of the brace is apt to split under the driving of nails and the pressure may cause the brace to lift slightly and split the thin end.

A far better method of attaching braces is shown in Fig. 3 (b) where it is possible quickly to take care of the giving way of forms and the bracing pieces are not destroyed in changing forms. Here the upper end of the brace is cut to give a square end and on the form is nailed a piece of board with the heads of the nails projecting slightly to allow of easy drawing when the forms are taken down. Where nails are driven in posts, they become loosened and it is usually necessary to drive other pieces alongside, just as soon as the pressure becomes excessive on the forms.

Another method of bracing forms is to construct them with bolts or wires between the front and back, thus causing the forms to assist each other in holding together. Bolted forms take less time to put up, use less lumber and all round are the most satisfactory of all methods used. Wiring comes next to bolts and braces occupy the third place so far as merit is concerned.

It seems needless to comment further upon the ordinary methods of bracing forms, except to say that the greater number of failures of braces are caused by the posts at the bottom giving way through the ground yielding, earth being a poor material to depend upon for holding forms rigid.

In all braced forms, the posts against which the ends of the diagonals rest should be driven deep. They should also be driven as nearly vertical as possible as experience shows that vertical posts are the stiffer, especially when the ground is poor. The top soil is seldom able to carry much of a load, hence the brace should be driven deep in order that it may obtain sufficient anchorage.

By using bolts or wire ties there is less danger than when braces alone are used and when possible to do without bracing the contractor should not depend upon it. Failures with bolted and braced forms are usually due to the ignorant use of ties.

When the designer has computed the matter properly and the foreman has drawings to work from it is impossible for properly secured forms to give way.

ARRANGEMENT OF BUILDING FORMS

Forms used in building construction should be so designed and erected that the slab centering and sides of beams, girders and column forms can be removed first and then allow the bottom of beams and girders to be supported for a longer time. Column forms will be considered in the next article.

And now doctors will be crying for cement. The latest use of it described in the daily papers is as a ready-made dressing for broken bones. A laborer in Columbus, Ohio, had his leg broken by a blow from a dump-bucket loaded with concrete. The concrete fell out on the broken limb, and set before he was moved. When the doctors went to set the broken bone, they found it incased in a very effective cast.

Design Methods in Concrete Construction—Analysis of Stresses in Rectangular Beams

By Jerome Cochran, C. E.

It is not the province of this series of articles to go very deeply into the higher, intricate details of the design of reinforced concrete as the subject is complicated at best, and the reader must be referred to such excellent treatises on design as Brook's "Reinforced Concrete; Mechanics and Elementary Design;" Hool's "Reinforced Concrete Construction," Vols. I and II; Ransome & Saurbrey's "Reinforced Concrete Buildings;" Taylor & Thompson's "A Treatise on Concrete, Plain and Reinforced;" and Turneaure & Maurer's "Principles of Reinforced Concrete Construction."

In the first and the second article, published in Concrete-Cement Age *for Jan., 1915, and Feb., 1915, were given, analytically and graphically, the general principles which govern the determination of the bending moments and shears in simple beams under applied loads. The analysis of stresses in reinforced concrete rectangular beams will be considered in the present article. The formulas used in designing T beams will be considered in the next article, as well as the application of formulas to the design of beams and slabs.*

INTRODUCTION

Concrete is weak in tension, i. e., a strain tending to pull it apart, but it is strong in compression, i. e., a strain tending to crush it together. Steel reinforcing material is placed in various forms near the tension sides of structural members to resist the tensional stresses. It may assist also in resisting the shear, the diagonal tension, and occasionally the compression stresses, as in doubly reinforced beams; and it gives additional compressive strength when used in columns.

This combination of concrete and steel, called *Reinforced Concrete,* causes the stresses that are set up in a reinforced concrete structure from dead and live loads to be somewhat complicated, for not only is the steel dissimilar in nature from the concrete which it reinforces, but the concrete itself is not homogeneous in the strictest sense of the word. It is usually customary, however, to assume that the lack of homogeneity of concrete is of second order as compared with that of the structure as a whole, and that the differences between the nature of steel and concrete are sufficiently large to overshadow completely the small differences which undoubtedly exist within the concrete itself.

Concrete, for all practical purposes, may be considered sufficiently elastic to warrant the application of the elastic theory to the analysis of stresses, although it does not possess the same elasticity as steel. In other words, the theories of the distribution of the stresses in reinforced concrete, which are based on the elasticity of the concrete and the steel, are sufficiently accurate for the practical purposes of design.

Tests of the elasticity of concrete have been made by the U. S. Government at the Watertown Arsenal, Mass., published annually in pamphlet form for distribution at moderate price, and the results may be found in *Tests of Metals* since 1898. Tests made at the Univ. of Ill. on reinforced concrete columns gave practically the same values for the coefficient of elasticity as for plain concrete.

The modulus of elasticity, E, may be taken as the quotient of the stress per unit of area divided by the deformation (that is, the elongation or the shortening) in a unit length, and is usually expressed as follows:

$$E = \frac{\text{stress per square inch}}{\text{deformation per linear inch}}$$

The adhesion, or bond, between steel and concrete is a very important factor and one that might be considered the foundation of all theoretical study of reinforced concrete. In fact, the whole success of reinforced construction depends upon the adhesion, or bond, between the steel and the concrete.

DESIGN OF REINFORCED CONCRETE IN GENERAL

The whole subject of reinforced concrete design resolves itself into the study of a few elementary types of structure such as the beam or girder, the slab, the column and the arch and all structures, however complicated, are either a modification or a combination of these elementary types; in fact, the slab is even a modification of the beam, being a beam supported on all sides.

With consistent formulas for the various elements, the allowable stresses should be the same for all elements of the structure considered, as the purpose of design is to produce not only a structure of adequate strength, but one of equal strength in its several parts.

The amount of bending or other forces produced by external loading is computed in the same way as in any other structure and was considered, in the case of simple beams, both analytically and graphically in Concrete-Cement Age for Jan., 1915, and Feb., 1915.

The problem in reinforced concrete is to distribute the resultant stresses in such a manner between the concrete and steel as to have the concrete take the compressive stresses and the steel take the tensile stresses, and thus require the least amount of each material. Sometimes steel is also used in compression, although with less success.

How the available compressive resistance of concrete and the tensile resistance of steel bars are utilized in reinforced concrete design will now be considered in this and other articles, the recommendations on reinforced concrete design of the Joint Committee, composed of members selected from the A. S. C. E., the Am. Soc. for Test. Mat., the Am. Ry. Eng. Assn., and the Assn. of Am. Portland Cement Mfrs., being followed because of their general acceptance as a standard.

THEORETICAL DISCUSSION OF REINFORCED CONCRETE BEAMS

The theory of bending used for reinforced concrete beams is different from the ordinary "theory of flexure" as used for homogeneous beams in a few particulars only, and this difference is more apparent than real. We consider here only the point of maximum bending moment; this is also the point of maximum depth, and we may assume both the compressive and the tensile resultant to be normal to a vertical section through this particular point.

The usual formulas for the design of reinforced concrete rectangular beams are developed upon the assumptions, (a) that a cross-section plane before bending continues a plane during bending, and (b) that stress and strain are proportioned.

In the first assumption the deformation or stretch at any point in the compressive portion of the beam is proportional to the distance of this point from the neutral axis, and the distribution of stresses is also proportional to the distance from the neutral axis so long as the moment of elasticity is constant. This distribution may be represented by a straight line as shown in Fig. 1.

The assumption known as Hooke's law—that stress is proportional to deformation—is not applicable when the modulus of elasticity changes, since the intensity of stress is no longer proportional to the distance from the neutral axis but changes according to the relation of the moduli of elasticity at different loadings, and the line representing the distribution becomes a curve.

THE STRAIGHT LINE THEORY

The straight line theory of distribution of stress, which is the simplest and most easily understood, assumes the following hypothesis as a basis for standard engineering practice, in reinforced concrete design:

(1) A section plane before bending remains plane after bending.

(2) The modulus of elasticity of concrete in compression is constant within the usual limits of working stresses.

(3) The strain in any fiber is directly proportionate to the distance of that fiber from the neutral axis; thus the variation of stress in the section above the neutral axis is indicated by a triangle.

(4) All tensile stresses are considered as resisted entirely by the steel reinforcing, no allowance whatever being made for concrete in tension.

(5) The adhesion, or bond, between the concrete and the steel within working limits is sufficient to make the two materials act together as a homogeneous solid.

(6) The neutral axis of any homogeneous section passes through the center of gravity of the section.

(7) The elastic limit of the material is not exceeded.

(8) Initial stresses are to be neglected. That is to say, initial stress in the reinforcement, due to contraction or expansion in the concrete, should be neglected.

It is recognized that some of these assumptions are not entirely borne out by experimental data. They are, however, no more inaccurate than other sets of assumptions which we would be able to suggest in our present state of knowledge; moreover, they are given in the interest of simplicity and uniformity. Beams designed by the straight line theory and properly constructed will be unquestionably safe.

The straight line theory has been adopted by the highest authorities here and abroad, and the results from it may be readily compared with the parabolic distribution of pressure in concrete above the neutral axis, which corresponds somewhat more nearly to actual test.

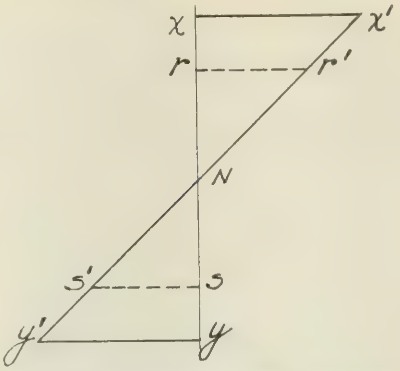


Fig. 1—Location of Neutral Axis in a Reinforced Concrete Beam

The two theories, however, require practically identical percentages of steel and the only difference is in the determination of the unit stress in the concrete. When using the parabola theory, about 15% lower compressive stress in the concrete must be used than when figuring by the straight line theory to obtain similar results. For example, 650 lbs. per sq. in. safe compression by the straight line corresponds to about 565 lbs. per sq. in. by the parabola theory.

LOCATION OF NEUTRAL AXIS

When a beam is of such composite character as steel and concrete, the neutral plane or axis is neither at the gravity axis of the section, nor does it remain fixed during the successive applications of varying loads. It is, then, of first importance that the position of the neutral axis be determined as accurately as may be. This is done by means of measurements of the deformations at the compression edge, and at the plane of the reinforcing bars, according to Brook's "Reinforced Concrete," p. 26. If in Fig. 1 the deformations be xx' and yy' the neutral axis, N, is located by connecting $x'y'$ with a straight line intersecting xy at N. The assumption that the plane section xy becomes the plane section $x'y'$ after bending is called "Navier's hypothesis," or the assumption of the conservation of plane sections. Careful measurements show some deviation from a plane, but, in general, the above assumption seems to be warranted by the results of observed deformations under working loads on concrete beams. If observations be made at rr' and ss', another determination of the neutral axis is made by joining r' s'.

An empirical formula sugested by Prof. A. N. Talbot, of the Univ. of Ill., for the location of the neutral axis under normal loading is given on p. 479 of Taylor & Thompson's "Concrete, Plain and Reinforced," to which the reader is referred.

The neutral axis for small loads is just below the center line of the beam, while for greater loadings it moves gradually nearer to the compression side. These facts are borne out by actual tests, according to Taylor & Thompson, who further state that as the first cracks develop, the change in position of the neutral axis is more sudden, and the distance from the compression side soon reaches its minimum, which for usual percentages of steel is from $\frac{3}{10}$ to $\frac{4}{10}$ of the depth from the top, after which the change for additional loading is inappreciable. At failure the change is sudden again.

ANALYSIS OF STRESSES IN A RECTANGULAR BEAM

The stresses in a simple rectangular beam at any vertical section may be represented as shown in Fig. 2, where the concrete in its upper portion resists the forces which tend to compress it, and the steel in its lower part resists the forces which tend to stretch and break it in tension. The large arrows indicate the direction in which the compressive and the tensile resistances act, which are, of course, opposite in direction.

The center of pressure of the concrete passes through the center of gravity of the triangle which represents the compressive stresses.

The center of tension in the steel is at the center of the rod, or, if there is more than one layer of rods, through the center of gravity of the set of rods.

In general the following nomenclature and formulas conform to the report of the Joint Committee on Reinforced Concrete of the A. S. C. E., Am. Soc. for Test. Mat., Am. Ry. Eng. Assn., and the Assn. of Am. Portland Cement Mfrs.

fs = tensile unit stress in steel, lbs. per sq. in.

fc = compressive unit stress in concrete, lbs. per sq. in.

Es = modulus of elasticity of steel, lbs. per sq. in.

Ec = modulus of elasticity of concrete, lbs. per sq. in.

$$n = \frac{Es}{Ec}$$

M = moment of resistance or a bending moment, lbs. ins.

As = area of steel, sq. ins.

b = width of beam, ins.

d = depth of beam to center of reinforcement, ins.

k = ratio of depth of neutral axis to effective depth d.

z = depth of resultant compression below top.

j = ratio of lever arm of resisting couple to depth d.

$jd = d - z$ = arm of resisting couple.

p = ratio of steel to concrete. For rectangular beams,

$$p = \frac{As}{bd}$$

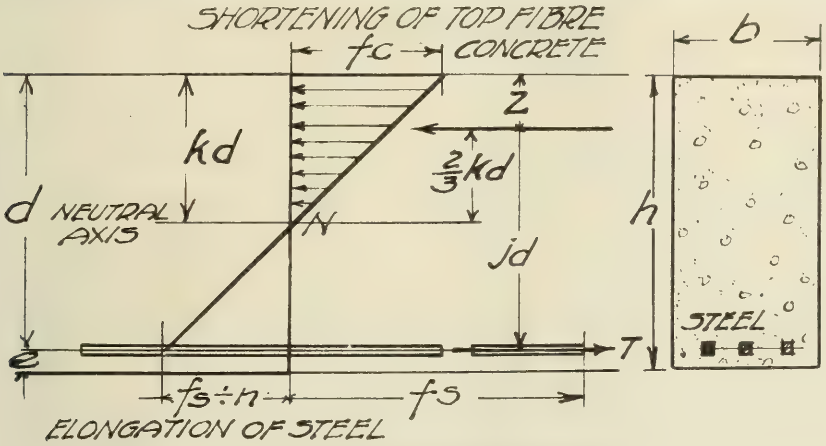


FIG. 2—RESISTING FORCES IN A REINFORCED CONCRETE BEAM

In Fig. 2 a vertical section is shown with the deformations produced by the bending of the beam. We assume (a) that a cross-section plane before bending continues a plane during bending, and (b) that stress and strain are proportional. Inspection of the diagram shows that the upper fibers are shortened, the lower fibers extended under the load;—the neutral axis forms the division line between shortened and extended fibers. The assumption of plane sections is evidently equivalent to assuming that the deformation of any fiber is in direct proportion to its distance from the neutral axis, and thus we have

$$\frac{\text{deformation in steel}}{\text{deformation in extreme concrete fibers}} = \frac{d\,(1-k)}{kd} = \frac{1-k}{k}$$

We further assume that the stress on any small unit is directly proportioned with the deformation, and since deformation

$$= \frac{\text{stress per sq. in.}}{\text{modulus of elasticity}}$$ we have

$$\frac{\frac{fs}{Es}}{\frac{fc}{Ec}} = \frac{d(1-k)}{kd} \text{ or } \frac{fs}{nfc} = \frac{1-k}{k} = z \quad (1)$$

from which

$$k = \frac{1}{1+\frac{fs}{nfc}} = \frac{1}{1+z} \quad (2)$$

Solving formula (1) for fc

$$fc = fs\,\frac{k}{n(1-k)} = \frac{fs}{nz} \quad (3)$$

Equating the total tension in the steel and the total compression in the concrete, we have

$$fs \times p \times d \times b = 1/2 \times fc \times kd$$

Cancelling out the db which occurs in both equations, we have

$$pfs = \frac{fck}{2} \quad (4)$$

If the value of k in formula (2) be submitted for the k in formula (4), we have

$$p = \frac{1}{2\,\frac{fs}{fc}\left(1+\frac{fs}{nfc}\right)} \quad (5)$$

According to the principles of mechanics the sum of the horizontal forces acting on a vertical section must be zero, hence the resultant force in the compression flange must equal the resultant force in the tension flange, or

$$A \times fs = \frac{fc}{2} \times kd \times b$$

and the moments are also equal, $Ms = Mc$

$$Ms = As \times fs + jd = pfsjbd^2 \quad (6)$$

$$Mc = \frac{fc}{2} \times kd \times b \times jd$$

$$= \frac{fc}{2} \times hj \times bd^2 \quad (7)$$

These equations apply when the maximum fiber stresses fc and fs are known; the reinforcement then is the critical ratio for these fiber stresses.

It is sometimes desirable to discuss the beam when a ratio of reinforcement is assumed which is not necessarily the critical ratio.

From the fundamental equations,

$$\frac{fs}{fc} = \frac{Es}{Ec}\,\frac{(1-k)}{k} = n\,\frac{(1-k)}{k}$$

From equations (6) and (7),

$$\frac{fs}{fc} = \frac{k}{2p} \quad (8)$$

hence

$$\frac{n(1-k)}{k} = \frac{k}{2} \text{ and } p = \frac{k^2}{2\,n(1-k)}$$

Solving for k we find that k = the square root of

$2\,pn + (pn)^2$ minus pn (9)

which is the position of the neutral axis, in terms of n and p and its location may be calculated with any percentage of steel for concrete and steel having modulus of elasticity. Referring to Fig. 2, we have

$jd + 1/3\,kd = d$

from which

$$j = 1 - \frac{k}{3} \quad (10)$$

The value of the moments of resistance Ms and Mc, may also be expressed without using k by substituting in formulas (6) and (7) the value of p from formula (5) and the value of k from (2), thus giving

$$m = b\,d^2 \left[\frac{f_s}{\frac{2\,f_s}{f_c}\left(1+\frac{f_s}{nf_c}\right)}\left(1-\frac{1}{3\left(1+\frac{f_s}{nf_c}\right)}\right)\right] \quad (11)$$

or

$$M = bd^2 \left[\frac{f_c}{2\left(1+\frac{f_s}{nf_c}\right)}\left(1-\frac{1}{3\left(1+\frac{f_s}{nf_c}\right)}\right)\right] \quad (12)$$

In the use of formula (12), fs and fc must be corresponding values and cannot be assumed independently of each other, since for any percentage of steel the ratio of fs to fc is a constant. See formula (5).

For a given quality of concrete and steel the values of fs and fc and n are constant, so that the term in brackets may be replaced by a constant $\frac{1}{C^2}$

We may thus write in place of formulas (11) and (12) the formula

$$M = \frac{bd^2}{C^2} \quad (13)$$

where C is a constant for any given concrete and steel. Values of C under different conditions are tabulated on pp. 519 and 520 of Taylor & Thompson's *Concrete, Plain and Reinforced,* to which the reader is referred.

Following directly from formula (13)

$$d = C \text{ into the square root of } \frac{M}{b} \qquad (14)$$

In the above formula M represents the bending moment which must be equal to or smaller than the moment of resistance. Also, since in Fig. 2 $d = h - e$, the formula may be written

$$h = C \text{ into the square root of } \frac{M}{b} \text{ plus } e \qquad (15)$$

from which the required height of the rectangular beam or slab may be directly obtained.

The area of cross-section of steel in sq. ins. is given by the formula:

$$As = pbd \qquad (16)$$

In a paper by Percy R. Wilson, Sec. of the Assn. of Am. Portland Cement Mfrs., read before the Assn. for the Advancement of Science in Philadelphia, parallel was drawn between the ancient Roman roads which have held together so well through centuries and the construction of the modern concrete roads in this country. According to Mr. Wilson, the making of roads as good as those produced by the ancients is by no means a lost art and American road buliders under American engineers are doing as good if not better work than was done by the builders of yore. Mr. Wilson says:

> Considered merely from the standpoint of the number of miles constructed and in use, the concrete road is a new type of highway in America. Its basic principle goes back, however, to the ancient Roman roads. These highways, which have endured centuries, were not altogether a matter of massive construction. They were held together by the use of puzzolana as a binding material, the volcanic cement, which also has kept intact many of the Roman edifices built centuries ago. In America, engineers have adopted Portland cement as a binding material for roads. Portland cement is as enduring and tenacious as the old Roman cement if we are to judge from tests upon specimens of like age.

Rapidity of placing concrete where quick-setting cement is used is a point which must be carefully attended to. Some cements obtain their initial set in about ½ hr. after being wet. A slow-setting cement should be used when a long time is likely to occur between mixing and final placing.

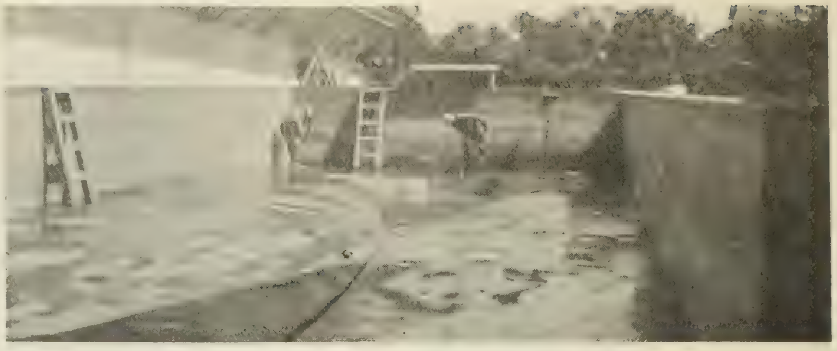


Fig. 1—Concrete Swimming Pool at Rockledge, Fla., Showing Concrete Ladders and 7-ft. Diving Hole at the Lower End

Construction of Concrete Swimming Pool at Rockledge, Florida

The swimming pool shown in the accompanying illustrations was recently completed at Rockledge, Fla. It is 22′ x 64′ inside measurements, with a depth varying from 3½′ to 5′, with a 7-ft. diving hole near the deeper end. The wall is 8″ thick at the bottom and 6″ at the top, with a 4-in. by 12-in. coping. Braces or posts are placed about every 6′ apart, giving a panel effect on the outside. The bottom is 4″ thick.

The walls were made of concrete mixed in the proportion of 1:4, of which one-third was shell and two-thirds medium coarse sand, which was obtained from the excavation. The shell took the place of fine gravel and was hauled from the river. The inside was finished with a 1:2 troweled coat and a brush coat of neat cement. The bottom was treated in a similar manner.

Reinforcing in the form of a diamond-shaped mesh with 2 runs of twisted fence wire were used in the floor and walls. Pieces of strap iron about ⅛″ x 1½″ x 36″ (straps that came around bundles of corrugated roofing) were used in corners and braces. This reinforcement was not heavy enough to prevent shrinkage cracks, which, however, were not of a size sufficient to cause any appreciable seepage of water.

No waterproofing was used, and, excepting at the shrinkage cracks, the outside of the walls did not show any sign of dampness even after the pool had been full of water for a week.

The excavation was about 2 ft. deep and was mostly in sand, although some "coquina" rock was encountered that required blasting.

The original plan called for two sets of steps from the pool, but by putting one set on the outside and substituting a concrete stepladder for the other, the pool is cleared of obstructions. The stepladder, shown in Figs. 1 and 2, required about ½ sack of Portland cement and cost about $3.00. The concrete steps would have required at least 4 sacks of cement and extra form work.

The side walls were built first, requiring much care to prevent the sand from interfering with the foundation that was on the outside of the wall. A better arrangement would have been to have constructed the bottom first, as shown in Fig. 3, leaving a shallow channel for the walls and allowing the reinforcement to project out. With such an arrangement it would be easier to cover the bottom with sand as a protection from the sun, and better alignment for the wall forms at the bottom would have been secured. The channel should be slightly wider than the forms require, in order to provide for wedges to facilitate moving the forms in lining them up. It is very easy to fill up the narrow places with additional concrete.

Water is supplied from an artesian well through a 2-in. pipe from the bottom of a small walled artificial spring hole, where it bubbles up and overflows into the pool, as shown in Fig. 2.

The U-shaped concrete drain was made in place, and covered by small flat concrete slabs, the slope being ⅛″ to the foot. It is 6″ wide and cost slightly more than 4-in. sewer pipe, and less than 6-in. sewer pipe. The outlet valve, also shown in Fig. 2. is made of concrete with a rubber facing and is opened by using a 2-in. x 4-in. stick as a lever to push it back.

Fig. 4 shows a sliding board used in connection with the swimming pool.

The cost of the pool without water

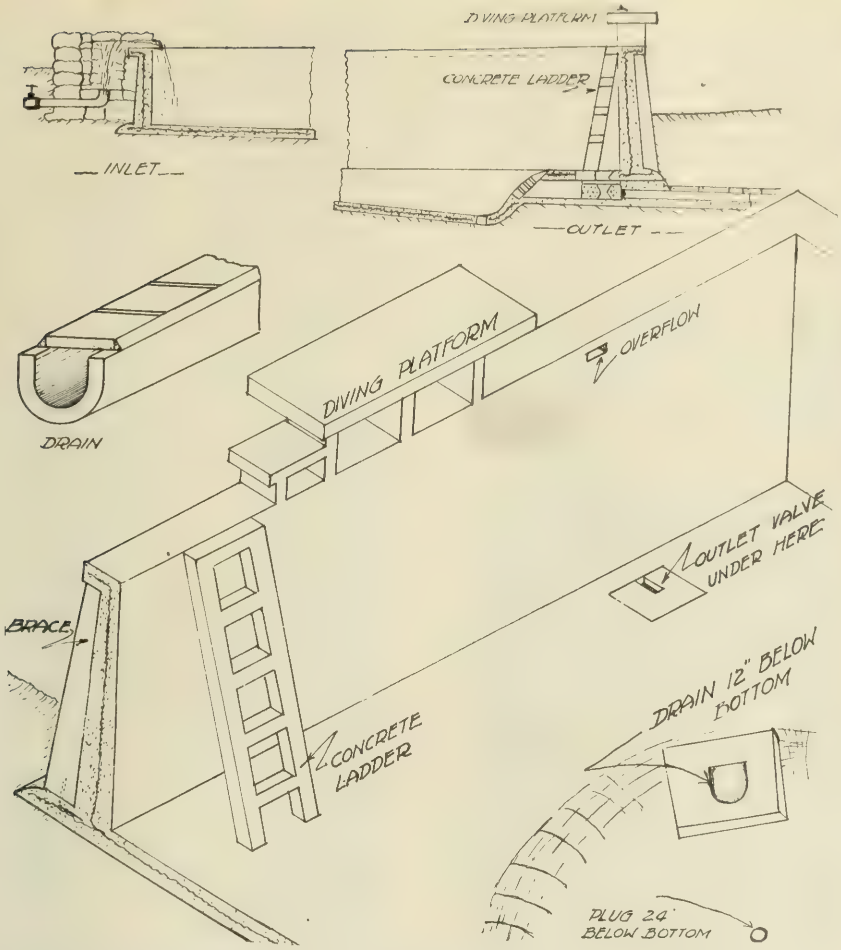


Fig. 2—Details Showing Concrete Swimming Pool at Rockledge, Fla.

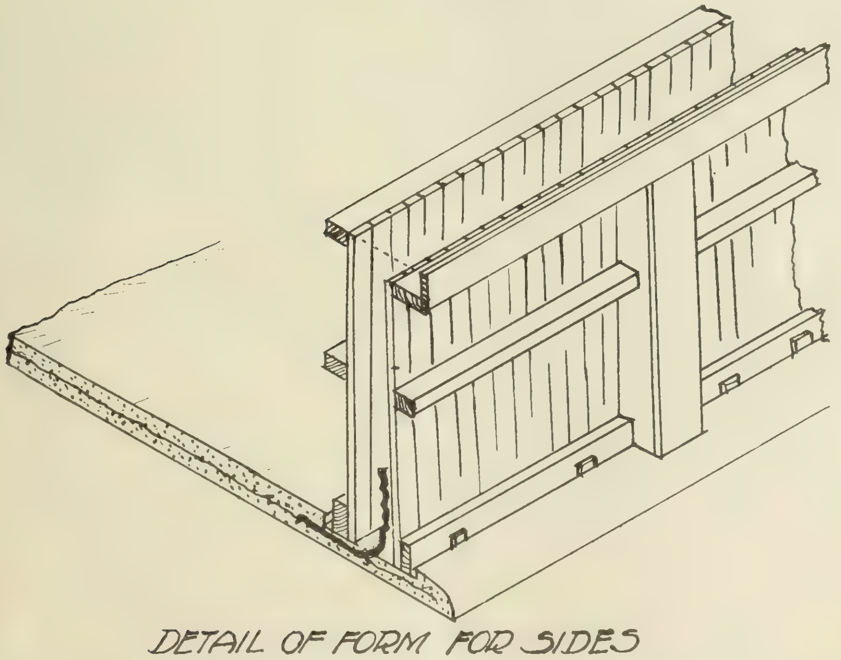


Fig. 3—Sketch Showing Method of Assembling Forms for Side Walls, and Mesh Reinforcement Projecting Up From the Bottom

supply or drain was about $550, but including piping for water supply and 270′ of drain tile, a large part of which was blasted through rock, it cost about $700. Seventy-six barrels of Portland cement were used, and cost about $2.40, delivered on the job, less the cost of sacks.

We are indebted to A. W. Devol, contractor, Cocoa, Fla., for the above information, the swimming pool being built for Robert Henkel, Detroit, at his winter home in Rockledge, Fla.

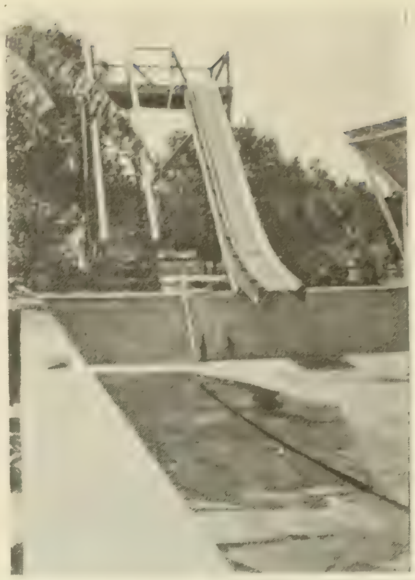


Fig. 4—View Showing Sliding Board Used in Connection With the Concrete Swimming Pool at Rockledge, Fla.

Among the descriptions of the queer old patents that are to be found in the early issues of the *Journal of the Franklin Institute* is an English patent granted in Jan., 1829, to William Hobson, Gent., for an improved method of paving streets. Strange to say, this old invention has many suggestions of the modern methods for constructing concrete roads, though in those days lime was used instead of Portland cement, which was practically unknown commercially. The sub-base was first prepared and upon this a coat of coarse mortar was laid consisting of lime, gravel or small fragments of stone. On top of this were placed the paving stones which were grouted with the lime. finely sifted gravel or coarse sand, the proportions being 1 part lime to 4 parts or 5 parts of fine material. The pavement was then thoroughly rammed and grouted again. Some of our concrete road construction has a strong resemblance to the work done under this old patent.

The tendency of the average contractor is to mix concrete too wet, the cement being washed to the lowest point of the forms, and the rest of the concrete suffers in consequence. Mixed too wet, concrete never attains its full strength. The mixture must not be so thin that it will seep through the joints in the forms.

Making the Models and Molds for Ornamental Concrete Work—Using Plaster and Gelatin

(Contributed)

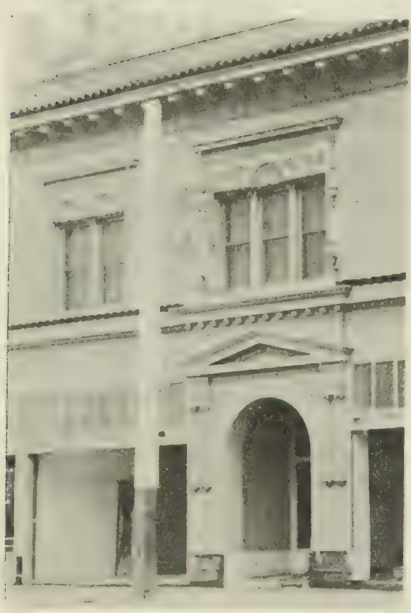


Fig. 1—Short Building, Fresno, Cal., With Ornamental Work of Concrete

The accompanying illustrations show not only the possibilities in decorative treatments of concrete but illustrate some of the steps in the production of the ornamental concrete castings.

Fig. 1 shows the Short Bldg., Fresno, Cal., and Fig. 2 shows some of the entrance way detail. All of this work was done by R. Keehn, Fresno.

Fig. 3 shows the workman with an original model at the right, and at the left the shell which is fitted over the model for the protection of a gelatin mold. The melted glue or gelatin is introduced around the model through the two holes in the shell, the shell being made larger than the model to give plenty of thickness for the glue. The shell is used to support the glue mold. The interior surface of the glue mold has to be hardened and waterproofed to prevent its disintegration by contact with the wet concrete. The glue mold is first dusted over with chalk or talcum powder to remove any trace of the grease which was applied to the model to prevent the glue from sticking. After this dusting, the mold is treated with a saturated solution of alum applied with a brush. This hardens the mold. When the coating of alum becomes dry, the surface is varnished with as good a grade of varnish as can be obtained. When the varnish has become perfectly hard, and just before the casting is made, the interior surface of the glue mold is greased over with raw linseed oil.

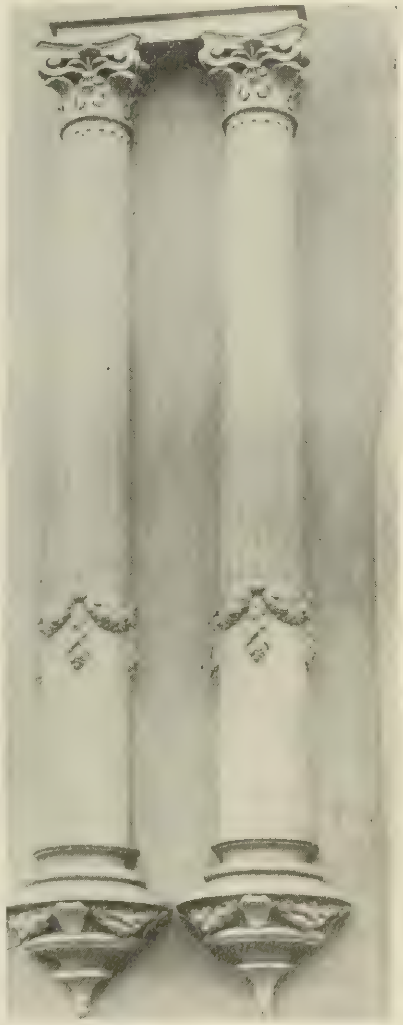


Fig. 2—Detail at Entrance of Short Building

In Fig. 4 a gelatin mold is shown on the left and the casting made from it on the right. In this case, the original model was worked out by hand in clay. In making a plaster model it is possible to make the original model without undercut and lacking the more intricate detail and after it is hard, carve away parts of the plaster to complete the design. In other words, the original plaster model, as first cast, may be only partially completed, finishing details being cut into the plaster. With this finished plaster model laid flat on a table a dam of sand is built up around the edges and the model covered with gelatin.

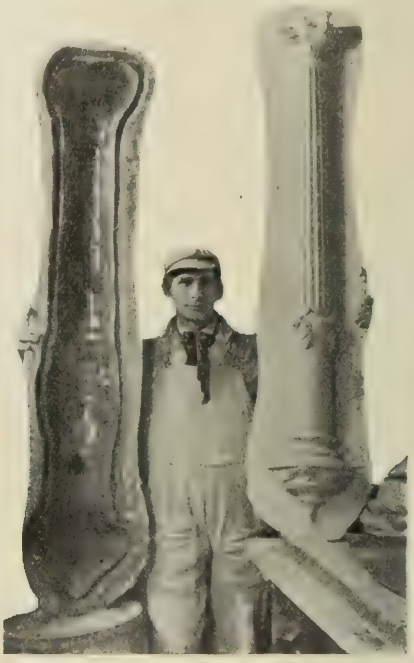


Fig. 3—Plaster Shell at the Left and Original Model at the Right, Used in Making a Gelatin Mold

Fig. 5 and Fig. 6 illustrate how plaster molds may be used, assembled from many separate pieces in order to avoid undercut and for easy removal from the final casting. The plaster mold, in this case, is in 17 pieces, including the shell. These have been outlined in ink on the photograph to make the lines of division more clear. The division is shown

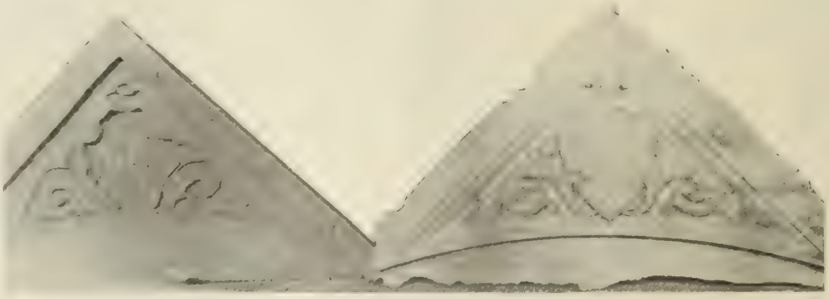
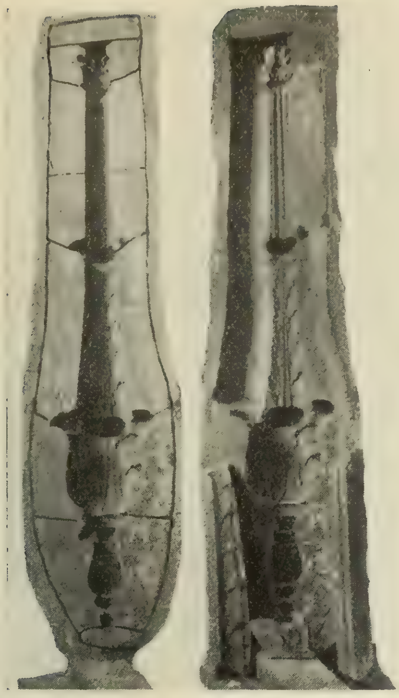


Fig. 4—Gelatin Mold at the Left and Original Plaster Model at the Right



FIGS. 5 AND 6—SHOW THE MANY PARTS IN WHICH THE PLASTER MOLD IS FREQUENTLY MADF FOR FACILITY IN REMOVING THE MOLD FROM THE CONCRETE CASTING

still further in Fig. 6, with part of the plaster mold removed. In making a plaster mold of this kind, various unconnected sections are applied on the original model with dams or fences of modeling clay to stop off the plaster at a given line. When the plaster is hard, and it must be handled rapidly, these joints are well greased and plaster then applied to the next section of the mold, the grease preventing one part of the plaster mold from sticking to another part while the work is being done.

In Fig. 7 is shown a plaster shell and in front of it are seven pieces of the plaster mold which fit into the shell in order to make the small concrete ornament which is shown just at the right of the shell.

Fig. 8 shows other plaster molds for small ornamental pieces assembled in the shells which hold them together.

Plaster molds and gelatin molds require very careful workmanship and the very best grades of material and facility in the work can only be gained by considerable experience.

Scrubbing concrete surfaces with ordinary scrubbing brushes with stiff palmetto or other fiber brustle, with a slight stream of water from a hose or can, will usually be sufficient if the concrete has not set too hard.

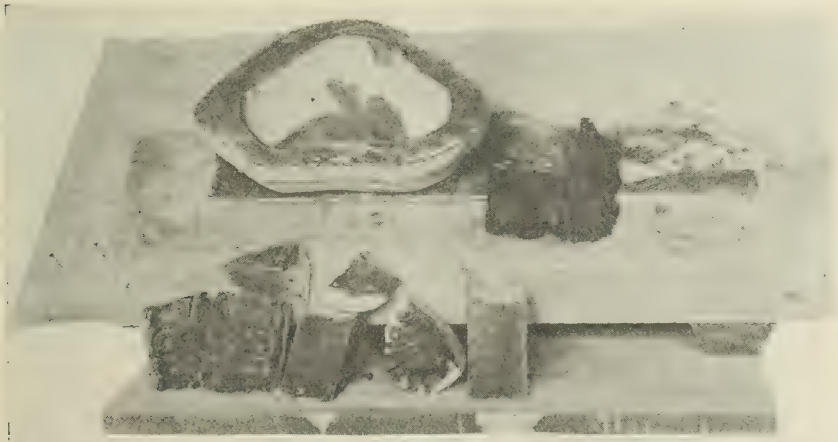


FIG. 7—A 7-PIECE PLASTER MOLD AND THE SHELL WHICH ENCLOSES THESE PIECES AND AT THE RIGHT THE ORNAMENT OF CONCRETE CAST IN THE MOLD

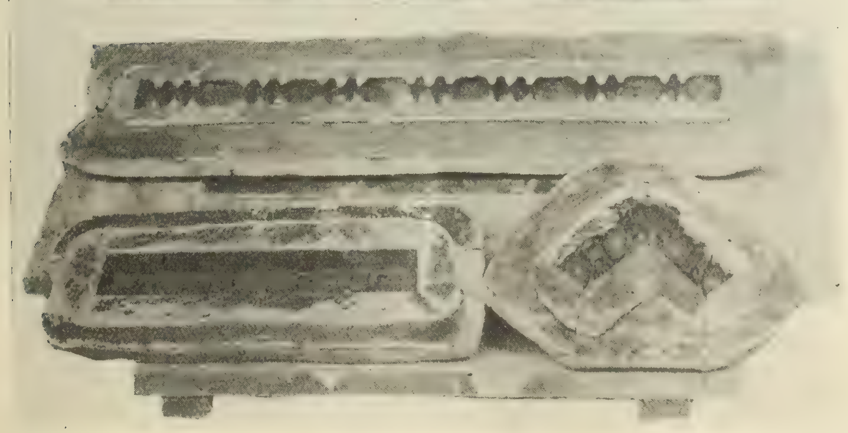


FIG. 8—PLASTER MOLD ASSEMBLED READY FOR CASTING

The Use of Glue Molds Under Serious Difficulties

BY NEAL M. JUDD[1]

Thirteen visible stone monuments, with the ruins of surrounding temples, pyramids and ceremonial courts are all that remain of a once powerful religious community, near the present station of Quirigua, Guatemala, C. A. Sixteen hundred years ago, if we may accept the figures of some students of Central American archaeology, this empty city was active with the enthusiasm of its inhabitants; now the calls of jungle fowl echo through the enveloping silence.

In an effort to preserve this home of a prehistoric people, the United Fruit Co. has recently created a reservation of 72 acres, thus separating from its enormous banana plantations a ruin the very existence of which remained unknown until 1840. In that year John L. Stephens, bearing special messages from the U. S. government to that of Guatemala, heard of the old city and sent his companion, F. Catherwood, to view the site. Mr. Catherwood's sketches, accompanying Mr. Stephenson's descriptions, introduced the Quirigua ruins to students of archaeology.

Forty-one years later, A. F. Maudslay, an English traveler, visited the ancient city. He secured hurried notes and photographs but returned for more detailed observations the two next years and again in 1894. While continuing his investigations of 1883 and 1894, Mr. Maudslay secured paper squeezes and plaster piece-models of several of the huge, carved stones for which Quirigua is so justly famous. Subsequent American expeditions added to Maudslay's list of models, notes and measurements, but a systematic study of the Quirigua ruins had not been attempted, I believe, until Dr. Edgar L. Hewett, Director of the School of American Archaeology, began a series of excavations in Jan., 1910. With one exception, these excavations have been continued annually since that date, and, in the expedition of last winter, the most recent of the series, I was a chance associate, having in charge that phase of the work which these paragraphs consider.

As a former religious center of the Maya Indians, the old city of Quirigua consisted of a principal temple area, a large ceremonial court, or plaza, and a number of associated temples and pyramids. The dwellings of its devotees were, supposedly mere palm shelters scattered through the forest-covered valley for some distance beyond the priests' houses.

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[1] National Museum, Washington D. C.

Mother Nature and all the little elements at her command have been working for generations in their attempt to erase evidence of man's invasion of the Quirigua jungle. Dripping water and swaying branches have cut and grooved the monument surfaces; earthquakes and growing plants have split and broken the heavy stones, thus destroying, to a greater or less extent, the lines and carvings with which they were all decorated. When Maudslay first visited Quirigua, in 1881, the ruins were almost hidden in the dense forest; the sculptured stones were overgrown with a mat of vines and moss in which even large trees had taken root. This growth was removed at that time for photographic purposes, but, owing to the tropical environments, the cleaning had to be repeated when the School of American Archaeology began its work and again when the recent expedition began operations in Jan., 1914. The possibility of irreparable damage has rather hastened a realization of the necessity as well as desirability of reproducing these sculptures.

The stone monuments at Quirigua are of two types: tall stelae or shafts, with human figures carved on both faces and hieroglyphic tables on the sides, and low, zoomorphic stones bearing similar inscriptions along the sides or front of the animal forms. Each stone was originally erected at the end of a Hotun or five-year period and its hieroglyphic inscriptions undoubtedly commemorated the important community events during that interval previous to the one in which the stone was raised. From an archaeological point of view, these monuments are valuable not only as examples of prehistoric American sculpture but also as records whose text may some day be intelligible to us and aid materially in broadening our meagre knowledge of the people who conceived them.

Each monument was cut from a solid block of scoriaceous sandstone, that is, the stone consists mostly of volcanic scoria but also contains quantities of sand and coarse gravel. The action of the elements has loosened many exposed pebbles from their silica cement, thus adding small pittings to the already rough, granular surface and increasing the difficulties of mold-making by resisting all efforts to force an inflexible substance into perfect contact with the surface of the stone and by tenaciously gripping that substance, once it had been properly driven into position. For such a superficial texture, glue proved the ideal agent, since the material of the molds was placed in a liquid condition and its natural elasticity, when hardened, permitted great distortion in removal.

Our process of mold-making was very simple. We began by building a light, plaster foundation around the base of the monument. This not only prevented the escape of the melted glue but also supported the superimposed forms which served as retaining walls for the glue molds. Above the foundation, a given section of the stone was covered with a layer of common clay mud, approximately 1″ thick. Over this a carefully jointed plaster form was built, of such dimensions as the breadth of the monument and the depth of its carving required. On the larger stones, the size of the forms was often limited by our ability to handle them—lacking mechanical means of moving heavy masses, we seldom made forms in excess of 15 sq. ft.

On the construction of these forms, wooden braces were built into them and anchored with ties of fibre. Such supports increased the strength of the forms and, in addition, their extended ends proved a convenience in handling. Each form was completed, allowed to set, and its edges trimmed before an adjoining form was begun. Upon the completion of the four forms composing each section, all joints were secured with temporary ties of hemp and the working platforms raised for a second series.

In this manner the whole surface of the monument was covered and then, beginning with the topmost form, we began the real process of mold-making. One complete, horizontal section was lowered each day, the subjacent layer of clay thrown aside, and the exposed stone surface thoroughly scrubbed, to remove what mud and lichenous growth still adhered. While the stone was drying, all iregularities on the inside of the four forms were scraped off and the surfaces painted with a thick coat of clay-water, as an aid in separating form and glue mold.

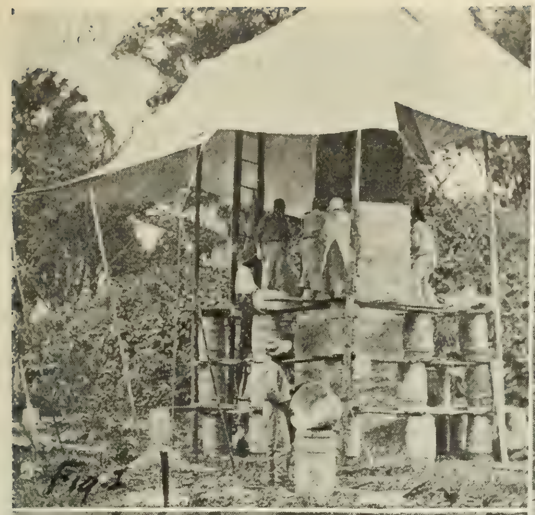
At the same time, glue tubs were placed over hot-water baths and their contents made ready for the daily pouring. That section of the monument to be reproduced and the inside surfaces of the waiting forms were thoroughly oiled with a composition composed of stearin, kerosene, and vaseline; the forms were raised to their original position and all joints were tied and covered with plaster and hemp. In their "original position", the forms were separated from the monument by an interstice equal to the thickness of the layer of clay over which they had been built. That space which the clay had occupied was later filled with melted glue. The thickness of the resulting glue molds, therefore, depended upon the thickness of the layer of clay they replaced. A section of the plaster form supported the back of each mold the face of which reproduced, in intaglio, the lines and carvings of the monument. From this countersunk, glue impression the cast was later taken.

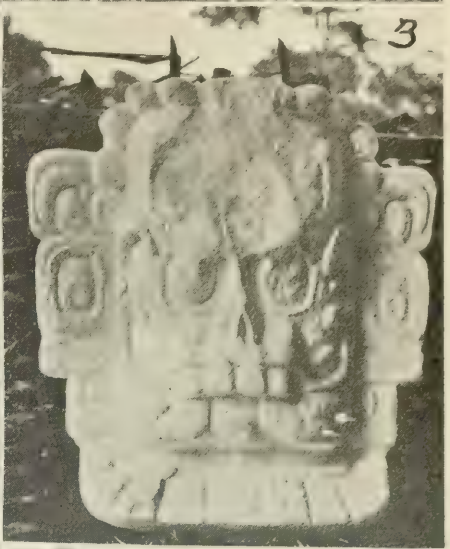
Those receptacles in which the glue was melted were ordinary, galvanized iron wash tubs, secured from the United Fruit Co. stores. Two sizes were employed, one containing the glue and a larger one in which the first tub might be placed, the two separated by three or four small stones and a quantity of boiling water. The larger vessel rested upon metal rods or pointed stones, leaving space for a fire underneath; the water it contained was kept at boiling heat until the glue had thoroughly melted, after which it was ready for the forms.

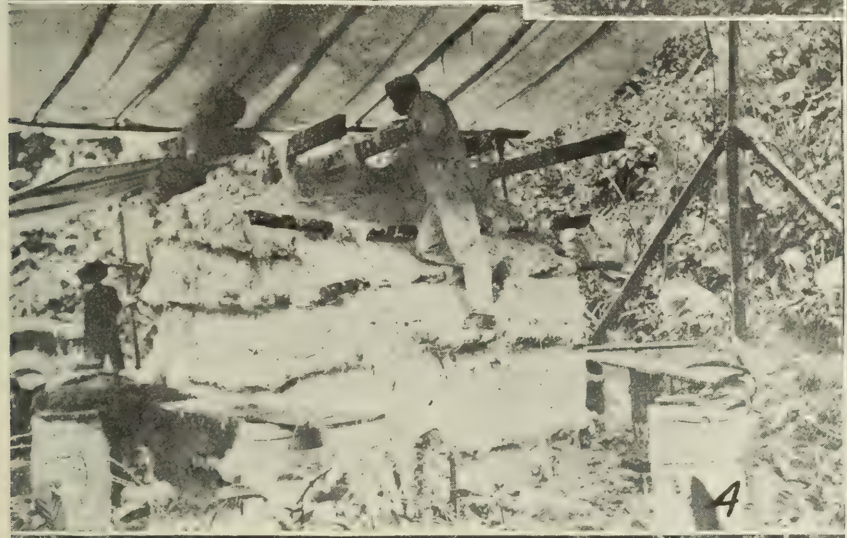
Pouring the glue was a simple matter and required only a number of pails and men to pass them. Since the normal glue mold shrunk considerably in solidifying, we increased the width of the forms by adding a low rim of plaster to the top of each section and, by filling this enlarged form with glue, secured a slight overlapping of the glue molds. This enabled us to trim them flush with the original edge of their plaster forms and assured perfect joints when the casts should be finally assembled. Through those forms that inclined from the perpendicular, airholes were drilled and later closed with clay as the liquid glue, rising in the mold-space, began to flow from them. Improvised funnels were sometimes out of the glue molds and also counused in filling the glue-space, the weight of the liquid remaining in the funnel forcing possible air-bubbles out of the glue molds and also counteracting the effect of shrinkage along the upper edge of the mold.

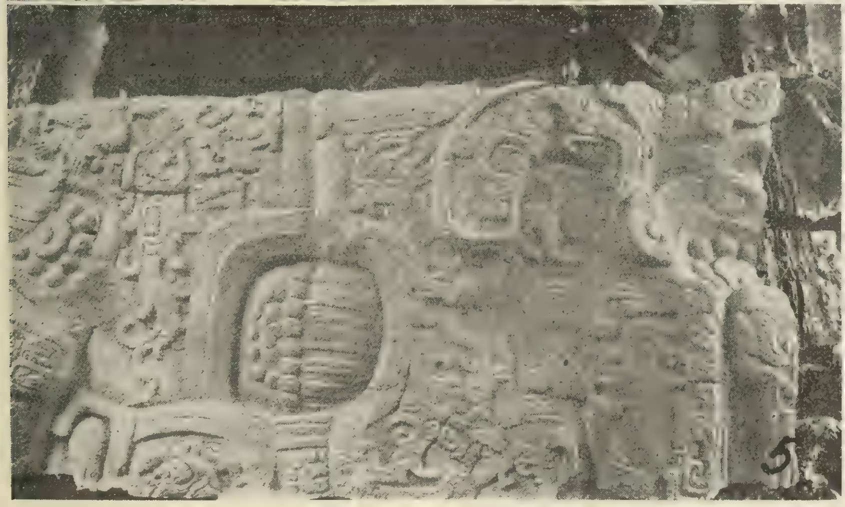
Glue molds must be thoroughly cooled and hardened before plaster casts may be taken from them. Better to obtain this condition, our molds were usually poured at sundown and left undisturbed until daylight. Then, as quickly as possible, the forms were lowered and the glue molds prepared for casting. Great care was taken to protect these molds from even the early morning sun since only a few moments' exposure served to soften and melt down the impression.

The surfaces of the glue molds were first dusted with French chalk









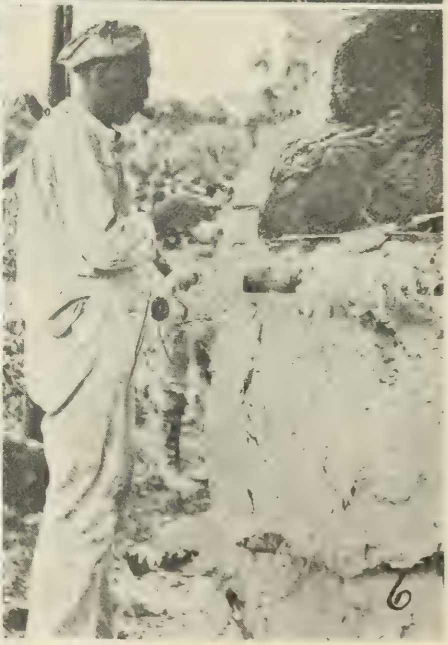


Fig. 1-6—Making Plaster Shells or Forms and Glue Molds from Ancient Monuments, Under Tropical Conditions. Photographs by Neil M. Judd

Fig. 1—Building plaster form or shell around one of the tall monuments and using empty plaster barrels in building up the staging. Covering of canvas for protection from tropical heat

Fig. 2—The Great Turtle. It reguired three months' work in the previous expedition of Maudslay to make a plaster piece-mold in 600 pieces. The present expedition produced glue molds and re-cast the manument in 11 pieces in 15 das.

Fig. 3—Plaster cast of a death's head from one of the tall monuments

Fig. 4—The first series of plaster forms, built up over a mud covering applied on the monument, reaches to the workman's foot, the second series to his waist; the top is in two pieces. Note saplings used to reinforce plaster. This is the work on the Great Turtle

Fig. 5—Cast from upper righthand corner of Great Turtle as seen in Fig. 2

Fig. 6—The edges of each section of the plaster shell were carefully trimmed before adjoining section was begun. This assured perfect joints

to remove any adhering grease. After this a saturated alum solution was carefully brushed into every pore of the mold surface. On an average, 1 hr. passed before this solution had completely evaporated but it always left a thin coating of alum that hardened the glue surface and protected it materially from the heat genrated by the setting of the plaster composing the casts. This alum-hardened surface was painted with a thin stearine-kerosene oil previous to casting.

Our casts were made in the usual manner, that is, the face of each glue mold was covered with liquid plaster and this was added to until a desired thickness had been obtained. During the construction of the casts each was carefully reinforced with wooden braces and hemp fibre to prevent wearing and breaking.

Each horizontal section of the reproductions of the stelae or upright monuments was composed of four parts, one for each side of the stone. These four parts, with their glue molds and supporting plaster forms, were usually bound together and braced from the inside before being separated from the glue molds. Since all plaster forms were constructed in conformation to the outline of the monument they reproduced, their corner joints were known to be exact; therefore, by carefully joining these forms and, while so joined, uniting the four parts of the cast they supported, the angles of the reproduction became as accurate as those of the original. Any other method should have required numerous measurements and much care in using them. Uniting the casts as we did necessitated uniform setting of the plaster on the four glue molds and a reasonable amount of speed in joining the casts. Even with our alum solution, the heat of the setting plaster soon melted the glue molds.

Each morning, as soon as the cast had been completed, attention was directed to preparations for the mold that was to follow. The forms were lowered from the next section on the monument and the stone prepared as indicated in preceding paragraphs. The glue molds just used were cut into small pieces and spread for drying; the forms were destroyed and carted into the jungle. It is interesting to note that melted glue, left in pails or tubs, would neither cool nor solidify but deteriorated within a few hours. Also, if the drying fragments of the discarded glue mold were carelessly spread and a free circulation of air prevented, they invariably sweated and soured, rendering them unfit for further use.

Our party entered the field with no experience and but little knowledge of the use of glue molds. During such preliminary experiments as we could conduct while awaiting the arrival of our materials, we learned that, in the tropics, glue or gelatin molds require more careful preparation than in the States. Our first pourings were too thin and resulted in soft, rather sticky molds. It was soon apparent that mere dampening of the dry glue flakes gave a thicker, heavier pouring and a more satisfactory mold than was possible with well soaked gelatin. The impossibility of obtaining cool water for casting also brought its difficulties—speedy work was our only means of overcoming the resulting inconveniences. Another vexing problem was met with in the drying shed, where minute worms developed a habit of exploring the interior of our plaster casts. Denatured alcohol, applied to the plaster, semingly increased their prodigious appetites for they continued to honey-comb the casts unless each reproduction was frequently exposed to the direct rays of the burning sun.

The climate was, of course, the greatest handicap under which the expedition labored. We reached Qurigua at the begining of the dry season, a 90-da. period during which the rains are more irregular and of shorter duration than usual. Temperatures were distinctly tropical, a fact that only increased our troubles. Under such conditions, not only the nature of our medium but personal comfort as well, required a temporary shelter over the monument being cast. Accordingly, canvas tarpaulins were drawn over poles that reached above the stones, drop curtains being utilized when driving rainstorms or the afternoon sun threatened the exposed parts of the monument.

Through Feb., Mar. and Apr., the three months in which records are available, the average daily temperature, as observed on the shaded veranda of the nearest United Fruit Co. farmhouse, was 66° at 6 a. m.; 88° at 12 noon; and 76° at 6 p. m. In the small, open space where our work of reproduction was pursued, the temperature was obviously higher and more nearly unbearable. The direct rays of the sun were unmerciful and the 150-ft. wall of surrounding jungle successfully turned what occasional breezes would otherwise have freshened the plaza. A persistent, high humidity, added to this heat, was certainly a sufficient test as to the practicability of glue molds in the torrid zone.

For shipment, all casts were packed in wooden crates and protected by dried banana leaves. The fact that they survived the rough handling of Central American ports and reaced New Orleans with very little breakage was owing to careful and generous reinforcement of the casts rather than to abundant packing.

Our work was continued over a period of 4 mos., during which time casts were made of six colossal monuments. Each of these reproductions is an exact duplicate of its original and exhibits not only every line and carving of the primitive sculpture but the very texture of the stone itself. Compared with the results obtained by other processes, the casts from our glue molds are so vastly superior as to beggar description. The completed reproductions are to be installed at San Diego, Cal., for the coming Panama-California Exposition and later removed to the halls of the School of American Archaeology at Santa Fé, N. M., where duplicates will be cast of concrete.

In a recent issue of a cement publication the heading appears "Fire Destroys Everything But Concrete." This headline is a familiar one and might be used to describe the results of almost any conflagration that takes place in any part of the country. In the case especially referred to here, a large barn was burned down, imperiling the lives of 60 head of cattle and causing great losses of crops and farm machinery. All that was left were the concrete barn foundation and a concrete silo. Many a sermon of interest to farmers could be preached upon this text and when there is left after a disastrous conflagration nothing but the concrete foundations of the building an eloquent lesson is given of the importance of constructing everything about the farm in concrete, "for permanence."

Concrete aggregates should be protected from intense heat in summer, and from freezing weather in winter. If the materials have been subjected to the heat of the sun, they are liable to cause trouble in the mixer by tending to cake the cement. When there are indications that the aggregates have been frozen means should always be taken to thaw them out, either by forming a hollow in the material and building a fire therein, or by putting the material in a sheet metal pan under which a fire is lighted. Usually these simple methods are sufficient, although more elaborate ones might be employed.

Information and *Consultation*: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Temperature Measurements in Concrete Buildings

Discussed By
W. A. Slater,[1] J. W. Howard,[2] H. C. Berry[3] and D. A. Abrams[4]

"I intend taking temperature measuresments in a concrete building from one end column to the other on each floor and on the ceiling over the top floor. The distance will be about 350′.

1. "What kind of plugs or base marks would be best to use in order to keep the same marks during the period of testing?

2. "Could you suggest a simple way to arrange these points?

"I also intend measuring cracks at each end of the building in the brick walls and to note the changes taking place from time to time.

3. "Could you suggest any way to retain the marks or to make such measurements?"

By Mr. Slater

For measing the expansion of the concrete floor in a building 350′ long, the use of an invar steel tape measuring between marks scratched or cut on metal plugs set into the concrete at certain intervals seems to the writer to be the best method available. If measurements are to be taken at small differences in temperature and to several intermediate points in the floor, great care will need to be used in order to prevent the errors of measurement from becoming larger than the expansion or contraction. Due to a difference in coefficient of expansion in various lots of invar steel, it is important that the constancy of the length of the tape be checked. Precaution should be taken also to have pull on the tape the same at all times when in use. The importance of such care is apparent when it is recognized that for each 10° F. variation in temperature the change in length of concrete per 100 ft. is not more than about .07 in. If change of length for an extreme range of temperature of perhaps 100° F. over the entire 350-ft. length of building be desired, the entire change will be enough larger so that the difficulties in the way of obtaining sufficient results will not be so great.

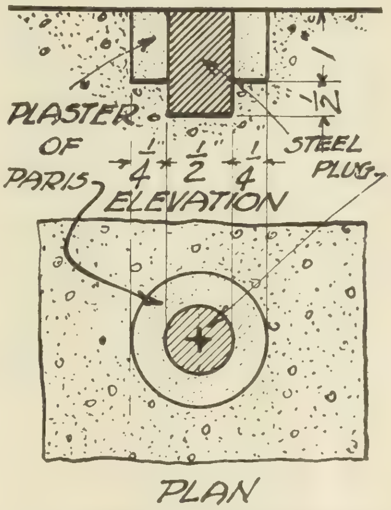


Fig. 1—Sketch Showing Method of Setting Plugs in Concrete

For setting the plugs in the concrete, the method described below, and shown in Fig. 1, has been very satisfactorily used by the writer for strain gauge measurements. Cut 1-in. hole 1″ deep with 1-in. star drill. Continue ½″ deeper with ½-in. star drill. Drive steel plug ½″ in. diam. 1½″ long into ½-in. hole and fill around it in upper portion of hole with plaster of paris. Scratch cross as shown. Be careful to set plug at such position as will not be traversed by a crack; otherwise plug may be loosened.

Engineering News, Mar. 19, 1914, describes measurements made by

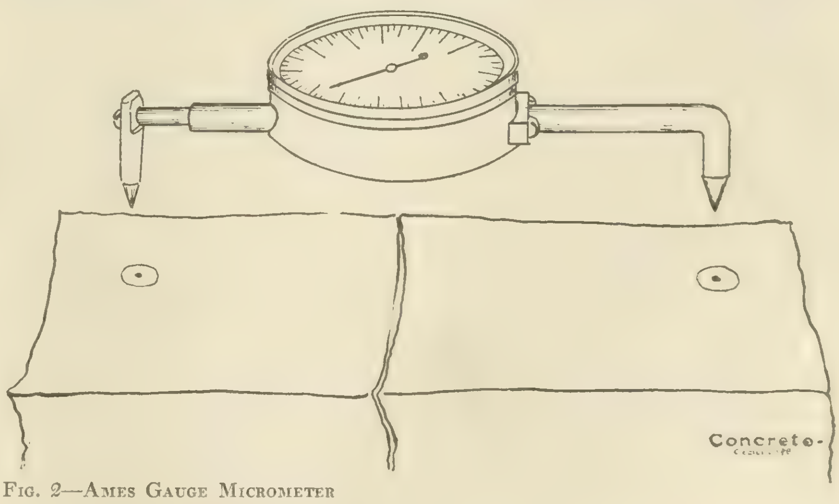


Fig. 2—Ames Gauge Micrometer

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[1] Eng. Exp. Sta. Staff, Univ. of Ill., Urbana, Ill.

[2] Instructor in Civil Engrg., Mass. Institute of Technology, Boston

[3] Prof. Materials of Constr., Univ., of Pa., Philadelphia

[4] Lewis Institute, Chicago

Prof. Howard of Mass. Inst. of Technology similar to those which the writer has in mind, and there may be reasons why the setting of plugs in lead expansion shields as described in this article would be advantageous.

Measurements may well be taken to some intermediate columns as well as from end column to end column.

The amount of opening and closing of a crack may be measured by means of a strain gauge of one of the types described in a paper "The Use of the Strain Gauge in the Testing of Materials" given in the 1913 *Proceedings* of the Am. Soc. for Test. Mat. For this purpose an instrument with a relatively large range of movement is likely to be important and the Howard strain gauge is well adapted for this purpose. A less expensive instrument having as great accuracy as is needed in this work, may be made up from an Ames gauge micrometer as shown in the accompanying sketch, Fig. 2.

The steel plugs required in connection with the strain gauge may be placed as described for use with a steel tape, but instead of marking the plugs with crosses scratched thereon, gauge holes should be drilled, using preferably a drill of about No. 54-gauge. The method of using the strain gauge is described in the article cited.

For large amounts of openings and closing of a crack, the measurement of the width of crack by means of a boxwood scale may be all that is necessary. The strain gauge will be of value only in cases in which considerable precision of measurement is important.

By Mr. Howard

In the measurements I made for the Aberthaw Construction Co. on a building in Boston, the plugs or base marks we used were expansion bolts set in the concrete to a depth of about $1\frac{1}{4}''$. These were found to be very satisfactory. The tops of these bolts were set flush with the surface into which they were placed. On the head of the bolt we made a file scratch to mark definitely the point of measurement.

In arranging these plugs I would suggest that if measurements are to be taken from one end column to the other at each floor the plugs set in the end columns be placed in a vertical plane by using an engineer's transit.

Relative to the measuring of cracks at the ends of the building I would suggest that expansion bolts be used and arranged as shown in Fig. 3, also that the point of measurement be a prick-punch mark instead of a file scratch.

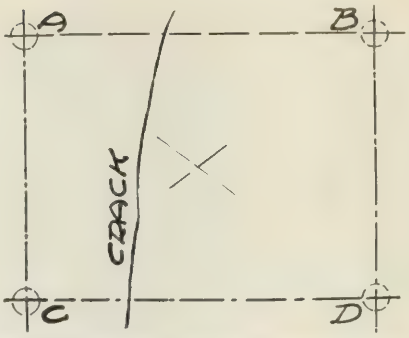

Fig. 3—Sketch Showing Arrangement of Expansion Bolts

A and *B* to be at same elevation.
C and *D* to be at same elevation.
A and *C* to be in same vertical plane.
D and *B* to be in same vertical plane.

Measurements to be taken shown by dash lines. Plugs arranged in this manner would give the direction in which the crack was taking place.

The measurements I made for the Aberthaw Construction Co. were made at the base and the top of the building. The end points were marked by expansion bolts. Expansion bolts were also set at the center and the quarter points both in the base and at the top. The top points were vertically over those in the base when the first measurements were made. When the second measurements were made these points were again tested to see whether or not they were still in the same vertical plane. In most cases they were found not to be and the difference showed the amount of movement and direction of movement of the building. Level readings were also taken on the base plugs to determine whether or not any settlement had taken place.

By Prof. Berry

We use a piece of $\frac{3}{8}$-in. round rod about $2''$ long driven into a hole made with a Rapid Fire stone drill.[5] With this drill a hole $1''$ deep may be made in concrete in about 1 min. The $\frac{3}{8}$-in. rod drives in tight. Into this rod we drill a small hole about $\frac{1}{16}''$ and ream it slightly. Into this we set the ends of the Berry strain gauge. This instrument is regularly made for lengths up to $20''$.

I think the above answers the method of arranging the points. These points could be made about $8''$ apart, and so as to include one of the cracks mentioned. The readings on such points would indicate the changes in the opening in the crack in the main.

I think my method would retain the marks indefinitely. As to making suggestions for making the measurements: I am not clear as to what the inquirer wishes to do. If he expects to get the expansion of the building as a whole he should preferably make the readings with a tape on the whole length, $350'$. But I think he will find that in that length there are a number of variations in the expansion, that some of it may be taken up in altering the alignment of the side of the building, in closing cracks, etc., so I would expect that he would find a good deal more out about expansion if he would make the readings on a length not greater than $10'$ and then read from $10'$ to $10'$ so as to observe the change in as great as distance as time will permit. He will thus learn something of the local changes. This could be done with a modification of the strain gauge giving the readings in 10-ft. lengths to the nearest 0.0001 in.

By Prof. Abrams

In previous work of this kind I have found that the plugs which are most satisfactory are made of $\frac{1}{2}$-in. round steel bar cut in lengths of about $1''$. These plugs should be set about flush with the surface, or slightly below the surface, in a hole about $\frac{9}{16}''$ in diameter. The space around the plug may be filled with cement, but my own experience indicates that best results are obtained by using molten lead for this purpose. Of course, lead cannot be used in cases where the plugs are set in the ceiling or in a horizontal position.

It would seem impracticable to attempt to give any suggestions as to the best method of arranging these points, without knowing more of the layout of the building and the space which will be available for this work. The amount of labor involved in making these measurements will be greatly reduced by using as long a gauge length as possible. In some experiments on a railroad bridge, Prof. H. F. Moore, of the Univ. of Ill., used a gauge length of about $5'$. For this purpose a strain gauge of the Berry type[5] was dismantled and a long wooden bar inserted in such a way as to give the gauge length required. This seems to be about the most feasible method for making the measurements which are necessary in studying the effect of temperatures on large reinforced concrete buildings. For indoor work or unexposed places, a wood bar would probably give as little trouble as a metal bar, unless invar steel could be obtained for this purpose.

I believe that by using metal plugs in the way I have indicated, and leaving them in place, no trouble would be experienced in retaining the gauge points for an indifinite time.

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[5] H. C. Berry, Prof. Materials of Constr., Univ. of Pa., Philadelphia

A full discussion of the instruments used in work of this kind, and the details of preparing the gauge points making the observations and reducing the data, will be found in the following papers:

- The Use of the Strain Gauge in Testing Materials, by W. A. Slater and H. F. Moore, *Proceedings* of Am. Soc. for Test. Mat., 1913, p. 1019.
- Tests of Concrete Building Under Load, by A. N. Talbot and W. A. Slater, *Bulletin* No. 64, Univ. of Ill., Eng. Exper. Sta.

The Dry Mixing of Concrete in a Batch Mixer Before Adding Water

Discussed By Rolf R. Newman,[1] Robert F. Havlik[2] and O. A. Crigler[3]

"Is concrete any better when the materials are turned in the batch mixer a few revolutions dry before the water is added than it is when made in the same mixer when the water is put in either first or with the materials?"

By Mr. Newman

There is no more important part of a concrete mixing specification than that referring to the dry mixing of the batch—whether mixed by hand or by machine. It is somewhat more important that a hand-mixed batch have plenty of dry mixing, but machine mixing by no means obviates this necessity.

One or two turns of the mixer will usually give the desired dry mixing and where the water is poured in by the pailful after the rock, sand and cement have been put in—an interval of at least two turns of the mixer will occur while the man in charge (for there is usually only one man on this job) is laying away his empty cement sack and picking up his pail ready for this next step in the process. If the water is supplied by tank or there is a second man on the platform ready to pour in the water it is necessary to require a slight pause in the procedure sufficient for dry mixing but this will generally occur through the mechanical necessities of the case.

By Mr. Havlik

We first pour the water into the drum and then dump the gravel, sand and cement into the mixer with the power loader. We find that this procedure prevents caking of the concrete and keeps the mixer clean and in my opinion, mixes the materials far better than the old time-honored method of mixing the materials first and then adding the water.

No one who has used mixers to any extent will deny that in the old-time method the cement always clogged up the blades and caked around the shell of the mixer. This is especially true with the drum type mixer, and it was our experience with this type of mixer that influenced us to pour the water in ahead of the other materials. We overcame this trouble and to our surprise we found that the concrete was mixed more quickly and apparently better than by the old-time method.

The reason for the mixer being cleaner becomes at once apparent when the process is analyzed. When you dump the water in first it thoroughly cleanses the inside of the mixer after each batch, whereas by the old process the dry materials come into contact with the wet blades and immediately cake on these parts and the mixer is never thoroughly cleaned until at the end of the day or at the noon hour, so in the new method the mixer is cleaned thoroughly after each batch is mixed, whereas in the old method it was cleaned but once or twice a day. What worried me most was that I had not thought of it years ago.

I adopted the scheme after having seen it used successfully by a builder of concrete silos, who is forced to use a somewhat dry mix and it is the dry mixes that cause the most trouble.

By Mr. Crigler

It is a well known fact that all architects and engineers specify mixing thoroughly dry before adding the water; but we must take into consideration that two-thirds of our specifications are copied; several different firms sell books of specifications, therefore they in the majority of cases follow old rules and it is to be determined that the old rules are not the best.

For the benefit of the mixer people I will say that it is better for the mixer if the water is added first, for when the material is dumped in and water added later the finer aggregate will stick to the wet parts of the drum, but again if the drum is thoroughly clean it would not make so much difference, but a mixer is nearly always abused. When a stop is made we fail to give the mixer a little attention and water and we drive it 8 hrs. to 10 hrs. and then expect it to clean itself, figuratively speaking.

In the late fall and the winter, when the days are exceedingly short, the mixer man is generally wet, tired and all ready to quit at the end of the day; therefore he does not clean the mixer thoroughly. This is my experience.

Some mixer people suggest that we turn a few revolutions dry, but this takes time. A mixer with a little water in it will more quickly mix the mass to an equality according to the eye, and while the revolutions are being made a little water can be added until the mass has a right consistency. I would add here that quite often when having the mixing done by hand I have dampened the aggregate with a little water, using sprinkler or hose to make the cement stick on windy days when the material is extremely dry. This saves time and cement. To determine the real facts in the case, tests might be made using both mixture, and the concrete specimens subjected to the 7-da. and 28-da. tensile and crushing tests. I would say right here that there are more mixers busy to-day that do not mix dry than do—it may be that we are too eager to turn out the concrete to think of the loss in strength.

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[1] Civil Engr., Riverside, Cal.

[2] Engr., Mooseheart, Mooseheart, Ill.

[3] Dallas, Tex.

Methods for Acid Washing of Concrete Products

Discussed By J. K. Harridge[1]

"In the treatment of concrete products with acid for the removal of the surface film of cement, which practice is the more desirable from the standpoint of results obtained and also from the standpoint of economy: The total immersion of the face in a tank containing the acid solution, or the use of a brush dipped in the

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[1] Barron & Harridge, Chicago

solution and applied on the face of the product?"

By Mr. Harridge

I believe the most practical and generally desirable way to use acid for the removal of the cement film from aggregate in the face of concrete block is with a scrubbing brush. The block are set with the face up, the acid applied, allowed to stand a few minutes and then scrubbed with stiff fibre or wire brush until the face shows the desired results. As soon as possible, the acid should be washed off with a liberal application of clean water. In some cases it is necessary to make several applications of acid before the face shows as well as desired.

In this connection I might add that in the treatment of exposed aggregate faces, we do not use acid. If the block are handled while the faces are still somewhat green, scrubbing with a fibre brush and water not only gives more economical results, but makes it possible to get a much larger range of textures than would be practical with the acid treatment. Acid is likely to cause stain of either the cement or the aggregate if it is not handled just so.

Concrete Vats and Tanks

Discussed By Wm. M. Kinney[1]

"Is it possible to construct reinforced concrete vats and tanks for buttermilk, wine, oil, pickles, sauerkraut, etc., that will be impervious, odorless, tasteless and sanitary?

"If so, how should the inner surface of the concrete receptacles be treated? Would you recommend the use of a water-glass, (sodium silicate) solution? If so, how would you apply the solution?"

By Mr. Kinney

Reinforced concrete vats and tanks for buttermilk, wine, oil, pickles and sauerkraut are used in many places and are entirely satisfactory if simple constructional precautions are taken.

The Institute of Industrial Research in Washington conducted for the Ass'n. of Am. Portland Cement Mfrs. a series of tests to determine the effect of commercial solutions on Portland cement concrete tanks. Nine different materials were used in the experiments and the results are briefly stated in the following summary and conclusions:

> "It will be noted, as the result of these tests up to the present time, that the following materials have been successfully stored in concrete tanks: Menhaden oil, lard oil, tanning solution, caustic soda solution 4%, and sauerkraut. The following materials have shown superficial disintegration of the concrete with considerable modification of the material itself: Sulphite liquor and cider vinegar."

Sauerkraut. The report further recommends that it is safe to store sauerkraut in properly prepared tanks and that plain concrete is as good as concrete specially treated, or even better.

The Fremont Kraut Co., Fremont, Ohio, has about 30 concrete tanks, most of which have been used for sauerkraut storage for about 5 yrs. They are of reinforced concrete, treated on the inside with a thin coating of paraffin, which is applied hot by painting on the surface and renewed once a year. Other kraut companies have had equal satisfaction in using similar tanks, untreated. Evidently the acid generated by the fermentation of sauerkraut is not strong enough to attack well made concrete.

Vinegar. Vinegar, however, does attack plain concrete, readily. Experiments conducted in 1911 by the Colorado Experiment Station prove that vinegar (acetic acid) will act upon porous concrete. In unprotected cisterns used for vinegar and other acid fluids, leaks developed and the vinegar turned black. This can be prevented by coating the interior of tanks with paraffin. Any tendency of acids to attack concrete is influenced by the character of the concrete, a porous concrete being more susceptible than a dense, impervious one.

Where proper care is taken in selecting, proportioning and mixing materials and the resulting concrete is placed in such a manner as to secure a dense, compact mass, and permitted to become thoroughly hardened before exposure, concrete tanks will offer much greater resistance to acids than when the concrete is porous as a result of careless proportioning, mixing and placing. Where circumstances make it necessary to treat the inner surface of the receptacle, paraffin should be used if the liquid to be contained is not to be heated. Where hot liquids are to be stored, sodium silicate may be used, or one of the commercial protective coatings now on the market.

Paraffin should be melted and applied by painting on with a brush, then using a plumber's blow-torch to drive it into the concrete. Following this, a second coat may be brushed on but not driven into the surface.

Sodium silicate or water-glass is applied by dissolving 1 part of the chemical in 3 parts or 4 parts of water, then painting on several coats of the solution at intervals of 24 hrs. until the surface indicates that the pores have been filled. Before applying any surface treatment, the concrete should be thoroughly dry.

Wine. The *Cement Record* for Dec., 1909, contains an article entitled "Glass-Lined Cement Tanks," from which we quote:

> "In a report recently made by Consul Alfred K. Moe, of Bordeaux, France, reference is made somewhat at length to the French utilization of cement tanks lined with glass. Some years ago cement tanks began to take the place of wooden tanks in a number of the large wine storage houses, one of the reasons apparently being the cheaper cost of material for cement tanks, as the price for timber has been gradually rising, and even at the higher prices was somewhat difficult to obtain. One of the objections, however, to the cement tanks was that in the storage of wines the acid in the liquid very often decomposed the cement, while the walls in turn absorbed the freshness of the wine. While, therefore, the wooden tanks were more expensive their value was greater, as they preserved the wine in a proper condition. The idea of coating the walls of the tanks with squares of glass tile joined with cement is said to have solved the difficulty, as a tartar forms on the this surface of cement and resists all acid attacks.
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> "As constructed in France, glass-lined cement tanks may be used for all kinds of liquids except those containing a large percentage of acids, the latter leading to the decomposition of the cement joints and the loosening of the glass plates. These tanks are particularly useful as storage receptacles for wines, alcohols, brandies, liquors, ciders, oils, gasoline, kerosene, turpentine, etc. It is said that tanks so constructed are neither affected by humidity nor by infiltrations, that they resist fire and inundation, and have a further advantage in that they are not liable to be struck by lightning as are tanks of metallic material. Variations of temperature effect a minimum loss by evaporation, the degree being reported at less than 1%. At equivalent temperature wooden tanks lose between 6% and 7%."

Concrete and Constructional Engineering, a London publication, in the issue of May, 1911, publishes an article entitled "Reinforced Concrete Wine Bins" based upon information furnished by *Le Beton Armé,* which we quote:

> "There have been numerous examples in France of the use of reinforced concrete for wine bins, some having been constructed of this material so far back as 1898, and the fact that the owners

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[1] Engr. in Chg., Inf. Bur., Universal Portland Cement Co., Chicago

express their complete satisfaction with this method of construction is sufficient proof of its suitability for such a purpose.

"One of the principal requirements in the construction of warehouses for storing wine is that the greatest possible amount of space is obtainable, and this requirement fulfilled by using reinforced concrete, as with this method the thinnest possible walls can be made, and every available inch of space can be used. Another advantage with reinforced concrete bins is that, unlike wood, cement is non-absorbent, so that the wine is preserved exactly as it was put in.

"Wooden bins are treated in various ways before being filled with the wine, but the most efficacious one for reinforced concrete has been found to be by applying a solution of tartaric acid, after which the bin is well rinsed out and ready for use."

Cement and Engineering News, for Dec., 1907, publishes an article entitled "Reinforced Concrete Wine Tanks," from which we quote:

"U. S. Consul Johnston states that reinforced concrete tanks are extensively used in Algiers, for storing wine and oil. The tanks have a capacity of from 260 casks to 2,500 casks of 52 gals. each. The concrete is faced with glass tiling 5½" x 10½" on the inside. Wine is stored, mixed and blended in these tanks."

Rock Products in its issue of Oct. 22, 1913, says:

"From the beginning of the California wine industry, wooden tanks and casks have commonly been used for fermenting and storing the material, but of late years many experiments have been made with receptacles of more substantial material. Underground tanks, or concrete lined cisterns, have been tried with some success; but up to this year the idea of portable concrete tanks had not been developed.

"This idea has now been successfully developed, however, by Snell and Dennis, concrete contractors of San Francisco, who during the summer built 36 portable reinforced concrete tanks in the winery of Arthur Lachman, a leading producer of fine wines and fruit brandies.

"The tanks have a capacity of 6,000 gals. each and stand 10' high, the walls having a thickness of about 2". The walls are arched over at the top, so that the casks can be tightly closed with wooden covers when desired.

"The tanks were completed in July, and have been in constant use for the last two months, in fermenting this year's vintage. Mr. Lachman says they are giving excellent service, showing no effect whatever from the chemical action of fermentation, and he believes they will last indefinitely."

Cement Age for July, 1910, contains a very interesting article by Horatio F. Stoll, entitled "Novel Uses of Concrete in One of California's Largest Wine Plants." This article refers to the Italian-Swiss Colony's vineyard and winery at Asti, in Sonoma County, Cal. Reinforced concrete is used extensively unique center dome built of rough rocks. in all buildings, and Mr. Stoll describes the largest wine tank in the world as follows:

"This great cistern is virtually a huge subterranean lake of wine, carved from the solid rock and lined with a 2-ft. thickness of Portland cement (with a glazed surface. The upper sides and the roof are of reinforced concrete, topped by a The Asti cistern is 84' long, 34' wide and 25' high.

In addition to the huge Asti cistern there are a number of 30,000-gal. capacity concrete fermenting tanks reinforced by steel rods, and a large concrete reservoir on a hill near by.

Buttermilk. In reference to the effect of storing buttermilk in concrete tanks, *Concrete and Constructional Engineering* for Feb., 1913, reports an interesting address delivered by W. Laurence Gadd, before the Concrete Institute, and from this published report we quote:

"Lactic acid is produced by the fermentation of milk, brought about by the micro-organism bacterium lactis, and is a possible acid to come in contact with concrete structures in farm buildings. The action of this acid is confined to combination with calcium hydrate, forming calcium lactate $(Ca\ (C_3H_5O_3)2+5H_2O)$. This salt is soluble in water and in wet situations would be readily leached out of concrete in which it was formed, so that the deleterious effect of lactic acid would consist in the gradual removal of the lime hydrate, which plays an important part in the induration of concrete. For practical purposes, it is probable that this action would be very small.

"The following tests show the effect of prolonged immersion in a solution of lactic acid, prepared by fermenting milk, and removing the curd:

"Mortar 1:4 (ordinary building sand).

"Test pieces 1 da. in air, 27 das. and 3 mos. in the whey and in water respectively.

	Tensile Strength		Crushing Strength	
	28 das.	3 mos.	28 das.	3 mos.
In whey ...	430	470	4,700	6,700
	440	470	4,900	6,000
	435	470	4,800	6,350
In water ..	400	495	4,600	6,800
	410	480	4,750	7,000
	405	487	4,675	6,900

"This is, of course, a much more drastic test than would be likely to occur in practice, but the results do not disclose any marked deterioration caused by the lactic acid."

Concrete Tanks for Dye-Houses

Discussed By Leonard C. Wason[1] and Wm. M. Kinney[2]

"We are constructing some reinforced concrete tanks for a dyehouse. Since their construction was begun, it has been claimed that water from a concrete tank would be injurious for dyeing purposes. The question involved is simply whether or not water stored in such a tank will absorb anything from the concrete."

By Mr. Wason

Water stored in a reinforced concrete tank is likely to absorb from the walls of the tank a certain amount of free lime. This action may last two or three weeks, or it may last two months or more, depending upon circumstances. Some of this lime is slowly soluble in water, which accounts for the action. If water is allowed to run through the tank for a few weeks before the tank is used for dyeing purposes, the lime will be gradually washed off the surface of the tank, and the water will then be no longer hard from this source.

Some forms of sizing, which are used as a preliminary to painting concrete surfaces, contain considerable quantities of sulphate of zinc. The use of such a sizing on the insine of the tank would result in neutralizing the free lime otherwise otherwise absorbed from the surface.

By Mr. Kinney

Sodium silicate or paraffin may be applied to the inside of the tanks as a precaution, but water stored in untreated, reinforced concrete tanks will not be affected and should be perfectly satisfactory for dyeing purposes if proper care has been taken in selecting materials, proportioning, mixing and placing the concrete so as to secure a dense, compact mass and smooth interior surface, and if the concrete has been permitted to become thoroughly hardened before use.

Editorial Discussion

Water passing through a concrete wall will take in solution a certain amount of free lime and when the water evaporates from the surface of the concrete this free lime will be deposited on the surface and is generally known as efflorescence. In case any free lime is absorbed by the water in the tanks some trouble might arise, but it would be easy enough to wash the inner surface with an asphalt wash to prevent an accumulation of lime on the surface.

No sand which contains small particles of coal or lignite should be used for the outside finish of any concrete, although sand of this character may be used in the interior portion of heavy pieces of concrete work. The sand for exterior surfaces should be of a bright, uniform color.

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[1] Pres. and Mgr., Aberthaw Constr. Co., Boston

[2] Engr. in Chg., Infor. Bur., Universal Portland Cement Co., Chicago

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Painting Concrete Surfaces and Bonding New to Old Concrete

—A LETTER FROM C. J. CASE[1]

In looking over my CONCRETE-CEMENT AGE, I find two articles that interest me very much, as I have had experience with both of the subjects treated.

First, as to the painting of concrete surfaces: 9 yrs. ago I made in plaster of Paris molds, 27 concrete bases for Corinthian porch columns, varying from 10″ to 24″ in diam. at the neck. The next summer I used those bases on a residence. In October, the exterior of this building, columns and bases, and everything else was painted with two coats of lead and oil paint, and one coat of lead, zinc and oil paint. The house has been repainted but once since, and no part of the paint has ever peeled or chipped from the concrete.

Now, as to bonding new concrete to an old floor. Over 7 yrs. ago I placed in a dairy barn about 5,000 sq. ft. of concrete floors. Afterwards I removed some 40 or 42 wooden cow stalls which had been in 8 yrs., and put in Louden pipe stanchions,[2] and to meet proper levels with the new floors, and alleys, I had to raise the old cow stall floors from 1½″ to 2″, with concrete. It bonded well and is still holding and the old floor had been in constant use for 8 yrs. as a cow stable floor.

Last summer I put a ½-in. top on a concrete sidewalk which had been down 5 yrs., and it is still holding.

In our High school basement last year, I put in a wedger 12′ long and 3″ thick on one side and a feather edge on the other to level up an old concrete floor, and it bonded.

In bonding new to old concrete, I use water and muriatic acid, equal parts, a stiff broom and plenty of muscle. Then, more water. Then, a neat cement and water paint. Then, a 1:2 of cement and sand, pretty stiff, and more muscle. Lots of it. Then water for a few days and protection from sun and wind. Anybody can do it, but many won't.

The Use of Plums in Concrete

—A LETTER FROM H. C. JOHNSON[1]

I am surprised to see that some on your side of the Atlantic consider that "plums" in concrete do not decrease the strength of the mass. It certainly increases the weight per cu. ft., but weight and strength are not synonymous terms in concrete ratios.

The whole thing boils down to *volume percentage of cement* in a concrete, i. e.,

$$\frac{\text{net amount of cement used}}{\text{finished volume of concrete}},$$

to put it in the form of a fraction. For instance, the amount of cement in an average 1:2:4 concrete (varies from 12% to 17%) is 14% and is obtained by dividing the reduced volume, on wetting, of cement by the finished volume of concrete. Loose cement reduces on adding about 22% water to .7 of original volume.

If "plums" are placed in concrete down goes the crushing or shearing resistance since only the cement "cements," and the more of it the stronger the concrete—statements to the contrary notwithstanding.

The Use of Hand, Hammer Crushed Brick in Concrete Work

A LETTER FROM C. M. WOOD, M. E.[1]

The writer, while acting as construction engineer for an irrigation company in the Rio Grande Valley of Tex., had occasion several years ago to use crushed brick for concrete. The work in question involved among other things a deep concrete pit 20′ 6″ x 41′ 9″ in plan, the floor of which was 18′ 6″ below the ground level and 2′ 3″ below the mean low water of the Rio Grande, this pit being utilized to house two double-suction centrifugal pumps, belt-driven, and by thus locating the pumps in the pit we were able materially to diminish the suction lift, and at the same time take advantage on the discharge side in the event of the river rising, which it usually did once or twice each season.

No rock of any description was available for concrete work, and as the company had been making its own brick for some time for use in siphon walls, culverts, and small foundations, the writer, more from necessity than choice, experimented with broken brick as a coarse aggregate for use in concrete, first using concrete thus made for survey monuments, and then for light foundations. The results of such experiments were highly satisfactory. It was, therefore, decided to utilize broken brick in making the concrete for this pump pit. Labor being exceedingly cheap (Mexicans at 6½ cts. per hr.) no additional expense was entailed in the purchase of a crusher to break the brick to a 2-in. size. After a few days experimenting along this line, the writer employed some 20 Mexican boys, in age from 10 yrs. to 18 yrs., paying them 4½ cts. per hr., and supplying each boy with a hammer with which to break the brick to the proper size.

The sand available for concrete was exceedingly fine, but clean, being obtained from shallow pits dug along the shore of the river, so, therefore, no endeavor was made to keep the broken brick to a uniform 2-in. size, in fact, the opposite was desirable, endeavoring to grade the pieces from ½″ to 2″.

Concrete was mixed in the proportions of 1 sack of cement, 2½ cu. ft. of sand, 4 cu. ft. of broken brick, for footings, while for the walls the proportions were changed to 1 sack of cement, 2 cu. ft. of sand, 3½ cu. ft. of broken brick. No waterproofing of any description was used, but the concrete was mixed very wet in a Smith mixer[2] and was well spaded after being poured.

Some 6 mos. after the work was completed it became necessary to cut into some of the concrete and it developed that such cutting was very slow when using the means at the disposal of the men, namely, sledgehammers and long striking chisels. The concrete showed upon examination that the brick-bats themselves had absorbed a considerable amount of cement mortar, and this made a concrete exceptionally hard and absolutely impervious to water; this fact has been attested several times in the past three years when the elevation of the water in the Rio Grande has risen some 12′ or more. A feature which may have had some bearing upon the fact that this pit has remained waterproof is that fresh burned bricks were used entirely for making this aggregate.

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[1] Cont. and Bldr., Troy, Pa.

[2] Louden Machy. Co., Fairfield, Ia.

[1] Engrg. Dept., Univ. College, Cork, Ireland.

[1] Engr. in Sales Dept., Chicago Portland Cement Co., Chicago

[2] The T. L. Smith Co., Milwaukee

Organizations

American Concrete Institute, Charles L. Fish, Secretary, Harrison Building, Philadelphia, Pa.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

Mid-West Cement Show, Omaha, Neb., Mar. 2-6, 1915.

National Conference on Concrete Road Building, J. P. Beck, Sec., 208 S. LaSalle St., Chicago.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention, Omaha, Mar. 2-6, in connection with Mid-West Cement Show.

Mid-West Convention and Show

In connection with the ninth annual Mid-West Cement Show to be held in the Auditorium, Omaha, Nebr., Mar. 2-6 inclusive, the Mid-West Cement Users' Assn. will hold its 10th annual convention. The program covers three days' session, Mar. 3-5 inclusive. Meetings will be held in the Hotel Rome. Aside from the usual addresses of welcome and introduction the first day's meeting will be taken up with an address by H. R. Park, Bruning, Nebr., on "Concrete in Southern Nebraska." George P. Dieckmann, Consulting Chemist, Northwestern States Portland Cement Co., will make an address on "Grading of Sands." Frank L. Ringer, Commr. Nebr. Mfg. Assn., Lincoln, will address the convention on "Workmen's Compensation." The session of Mar. 4 will open with a business meeting which will be followed by an address by Mr. Dieckmann on "The Modern Manufacture of Portland Cement." T. H. Johnson, asst. city engr., Sioux City, Ia., will make an address on "Concrete Pavement as Laid in Sioux City, Ia." P. P. Comoli will make an address on "Architectural Possibilities in Concrete Homes." Friday's session will also open with a business meeting which will be followed by an address by Harry I. Purcell, Chicago, on "The Problem of a Cement Products Manufacturer." Prof. L. W. Chase, of the Agricultural Dept., Univ. of Nebr., Lincoln, will make an address on "Concrete Silos in Nebraska." Prof. Clark E. Mickey, Univ. of Nebr., will give a talk on "Better Concrete."

All of the papers and addresses of the convention will be open for discussion and the feature of the meeting this year will be the inauguration of a question-box to encourage the development of less obvious subjects of interest as they may occur to members of the Association. If a question is of such a nature that a man does not care to get up and announce it publicly in the meeting, he is requested to write it out and drop it in the question-box, when it will be taken up in open meeting.

Writing in the *American Journal of Archaeology,* E. B. Van Deman takes up the old subject of the antiquity of concrete. He says:

> In no period was concrete used to any extent without facing except in foundations and other visible parts of buildings. Roughly at the beginning of the Christian era it reached the position of dominant material (or mode) of construction. Before 100 B. C. some monumental structures containing concrete were erected and from that time on the material was increasingly used, including exterior facings in concrete. The dome of the Pantheon, erected 123 A. D., is still regarded as the finest example of ancient concrete work extant. It is 142′ in diameter, with an opening of 30′ diameter at the top, and without showing appreciable injury has withstood the destructive influences of the weather for nearly 2,000 yrs.

New Books

Foundations: A short Text-book on Ordinary Foundations, including a Brief Description of the Methods Used for Difficult Foundations. By Malverd A. Howe, Prof. of Civ. Engrg., Rose Polytechnic Institute, Terre Haute, Ind., cloth, 6″ x 9″, 110 pp., 55 fig. John Wiley & Sons, Inc., $1.25 net.

The purpose of the book, as stated by its author, is to present in an elementary manner the fundamental principles upon which the proper design of foundations is based, with such examples as will serve to illustrate their application.

The text is divided into six chapters under the following headings: Supporting capacity of soils; wall footings and column footings; piles and pile foundations; chimneys and towers; bridge piers and abutments; methods employed for difficult foundations (such as pneumatic and open caisson work and the freezing process). The chapter headings quoted give an adequate idea of the scope of the book.

The task of condensing in one volume of 110 pp. a discussion concerning such a wide range of subjects as are embraced in foundations was not easy. Yet the author has tried to touch briefly upon most of the essentials and has developed in some detail the more important considerations.

The book, however, is elementary in character and intended primarily for class room work in technical colleges and it will prove useful for that purpose, although it will require considerable amplification in the form of lectures or other reading. An important feature of the book is the list of many references to other books and to current periodicals. This bibliography is very complete and only reliable information has been used. Viewed broadly, the method of treatment, together with the nature of the information, makes this book of some value to the practicing engineer.

The text is large and clear, the illustrations serve well their purpose, and the volume is neatly bound and of a convenient size.

Symmetrical Masonry Arches—Including Natural Stone, Plain Concrete, and Reinforced Concrete Arches. By Malverd A. Howe, Prof. of Civil Engrg., Rose Polytechnic Inst., Terre Haute, Ind. Cloth, 6″ x 9″, XXIV +245 pp., 35 illus. and 6 folding dwgs. John Wiley & Sons, Inc., $2.50 net.

In this second edition, Prof. Howe has made an attempt to correct the errors found in the first edition, and to simplify the demonstrations of the formulas. Most of the text has been rewritten and considerable new matter added. The tables of arches have been supplemented by a table giving arches built within the last 10 yrs.

A greater part of the book is taken up with the solution of examples, each step being arranged in detail so as to be easily followed by the student and engineer who has not specialized particularly along the design of masonry arches according to the elastic theory.

Short and simple solutions are given to those problems which do not require minute analyses. The simplest solution of the formulas for the horizontal thrusts and bending moments at the supports are given for the first time.

Both numerical and graphical tables are given, compiled from arch bridges already in existence and these form a valuable aid in checking calculations. In Appendix B is given a series of arch coefficients and an example illustrating their use in transforming a given arch to one having different dimensions. These tables accompanying the arch-coefficient method will be found of much use. Appendix D contains formulas for unsymmetrical arches, which will serve the occasional case in which symmetry cannot be maintained.

The chapter headings are as follows: Fundamental formulas, symmetrical arches fixed at the ends, examples showing the application of the formulas, etc., and typical arches. An extensive appendix contains tables and miscellaneous data pertaining to the subject.

Methods and Costs in Constructing a Combined Concrete Silo and Water Tank

The combined concrete silo and water tank shown in Figs. 1 to 7 inclusive, and described in the following article was erected for Frank L. Eagan at Hartford, Mich.

GENERAL DESIGN

The silo is 12′ in diameter and 36′ high, with a 5,084-gal. water tank 6′ deep on top. Pipes lead from the tank to windmill, residence, barn and hog pen. A hose is used to clean the floors of the hog pen, horse and cow stable and to fill holes for hog wallows.

The floor of the water tank was made 8″ thick, and the wall 6″ thick from the foundation to the roof.

The conical concrete roof was made with a 1.3 pitch and the eaves project 6″. The roof slab is about 4″ thick at the eaves and tapers to about 3″ thick at the top. Each of the dormer windows in the roof contains a sash with four panes, 12″ x 14″, which provide ample light.

The structure is built with a concrete chute as shown in Fig. 2. There is a continuous doorway as high as the silo. A ladder is provided for the remaining 6′, with iron bars placed in the concrete. There is a step in the ladder every 15″, and across the doorway every 30″ is an iron rod extending into the concrete on each side.

The malleable iron door fasteners are fastened to the center of the doors by $\frac{1}{2}$-in. bolts, and they are so constructed that when the arm is drawn down to a horizontal position the door is drawn taut in the door jambs. The arms of the door fasteners form steps and the ladder iron forms other steps about 15″ apart when the doors are in place.

One end of the door fasteners catches in cast iron sockets, which are embedded in the wall.

A concrete cone was built in the center of the water tank so as to take care of the pressure which might be caused by the water becoming frozen.

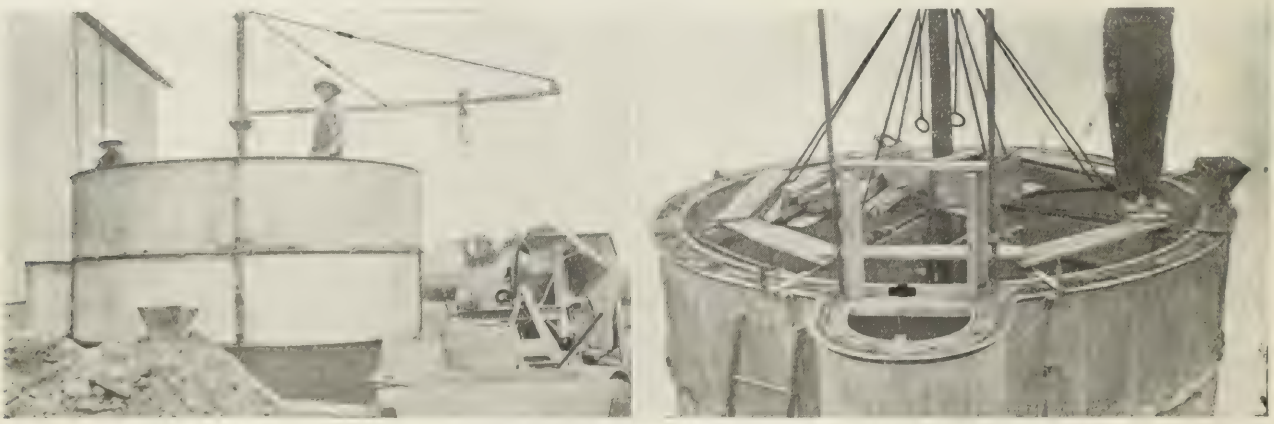
The structure is reinforced with triangular mesh steel woven wire, which is made with both single and stranded longitudinal or tension members. That with the single wire longitudinal is made with one wire varying in size from a No. 12-ga. up to and including a $\frac{1}{2}$-in. diam., and that with the stranded longitudinal is composed of two wires or three wires varying from No. 12-ga. up to and including No. 4 wires stranded or twisted together with a long key. These longitudinals, either solid or stranded, are invariably spaced 4″ o. c., the sizes being varied in order to obtain the desired cross-sectional area of steel per ft. of width.

No. 23 wire mesh was used in the first third of the silo, No. 4 for the next third and No. 5 for the last or top third.

The wire mesh was 12″ wide, which provided for a 6-in. lap every 3′.

Twisted iron bars, $\frac{1}{2}$″ in size, were placed 12″ o. c. each way in the bottom of the water tank and No. 23 wire mesh placed on top of the bars.

The conical concrete roof over the water tank was reinforced with No. 5 wire mesh and a $\frac{1}{2}$-in. twisted bar near the eaves and in the roof, forming a hoop so as to provide for the strain caused by the weight of the



FIGS. 1 AND 2—MOLDS AND OTHER EQUIPMENT USED IN CONSTRUCTING A COMBINED SILO AND WATER TANK AT HARTFORD, MICH.

Fig. 1 shows the molds raised and the men ready to raise the hoist or scaffolding, while Fig. 2 shows a man on top of the scaffold. The T-iron arms brace the molds from the center mast and spacers hold the molds to an even thickness roof pressing down. The dormer windows in the roof are also reinforced with wire mesh.

MATERIALS OF CONSTRUCTION

Universal Portland cement[1] was used throughout the structure. Field tests only, from actual mixtures, were made. The total quantity of cement used was about 75 bbls.

The aggregate was carefully selected bank-run sand and gravel from local pits, being clean and coarse, but not over ¾″ in size as a maximum. There were used about 54 cu. yds. of gravel in the walls and the water tank floor.

One roll of No. 23 triangular wire mesh,[2] consisting of 525 sq. ft., one roll of No. 4, consisting of 525 sq. ft., and two rolls of No. 5, consisting of 1,050 sq. ft., making a total of 2,100 sq. ft. of 971 lbs. of wire mesh, were used, besides about 300 lbs. of ½-in. twisted bars.

The 30-in. x 30-in. doors were made of two thicknesses of 1-in. cypress lumber, with tar paper between and held together with two 2-in. x 4-in. cleats. These doors were fastened by the Conklin door fasteners.[3]

MOLDS AND EQUIPMENT

The Conklin molds[3] are made of No. 16-ga. black sheet metal, reinforced at the top and bottom with 1½-in. x 1½-in. x 3/16-in. angle iron. The inside molds are reinforced in the center with 1½-in. channel steel.

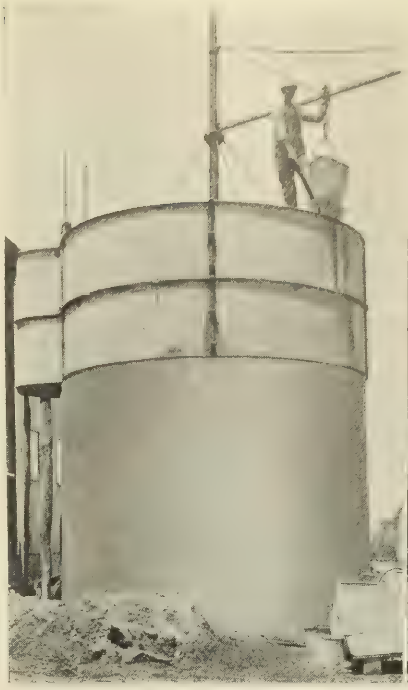


FIG. 4—POURING CONCRETE FROM THE DROP BOTTOM BUCKET INTO THE MOLD

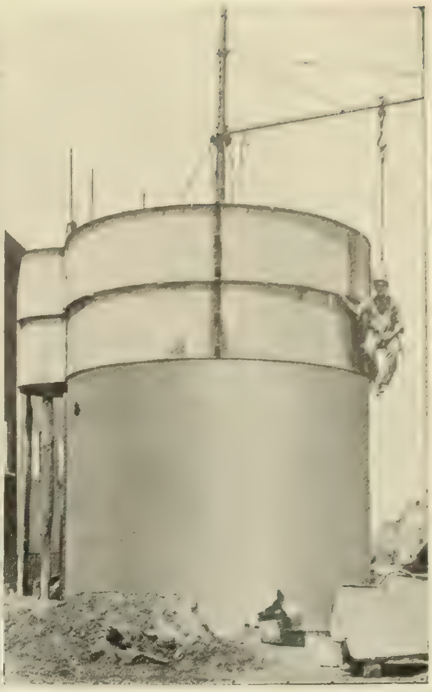


FIG. 5—REMOVING MOLD CLAMPS

After the silo is built a man may be suspended in the same manner to wash the wall

The Conklin molds include two complete rings (inside and outside), chute mold equipment for blocking off the doorway in steel, malleable iron clamps, two lifting hooks, cornice irons, steel mold spacers, steel mold blocks and four turnbuckles for chute.

Figs. 2 and 3 show the type of equipment used in constructing the silo. The machine carries its own scaffolding and is automatically lifted.

The machine is set up with a 4-in. center mast, carrying 8 T iron arms, 2″ x 2″ x ¼″ in size, so adjusted that the hoist can be used in diameters of 10′ to 20′. These arms carry a scaffolding at the top of the molds and keep the molds in a circular position. A second scaffolding is suspended about 7′ below, which enables the operators to handle the molds and finish the inside walls. The rods and chains that carry the arms are ½″ in size, while the rods carrying the scaffolding are ⅝″ in diameter. The mold spacers which are connected to the radial arms of the spider are shut down onto the top angles of the molds, and hold them in a circle and the proper distance apart; in this case, 6″.

The boom carries a concrete bucket with a capacity of about 3 cu.-ft., and is also used as a swing to enable the operator to remove the clamps on the molds and finish the outside walls.

The equipment usually includes 60′ of center mast, but silos of any height can be built by additional sections.

The machine was kept set up and used until after the roof was built.

In constructing the floor of the concrete water tank, the inside molds of the Conklin machine were taken out and placed on the ground. The outside molds were lifted to the second position, similar to that shown in Fig. 6. The spider or web of

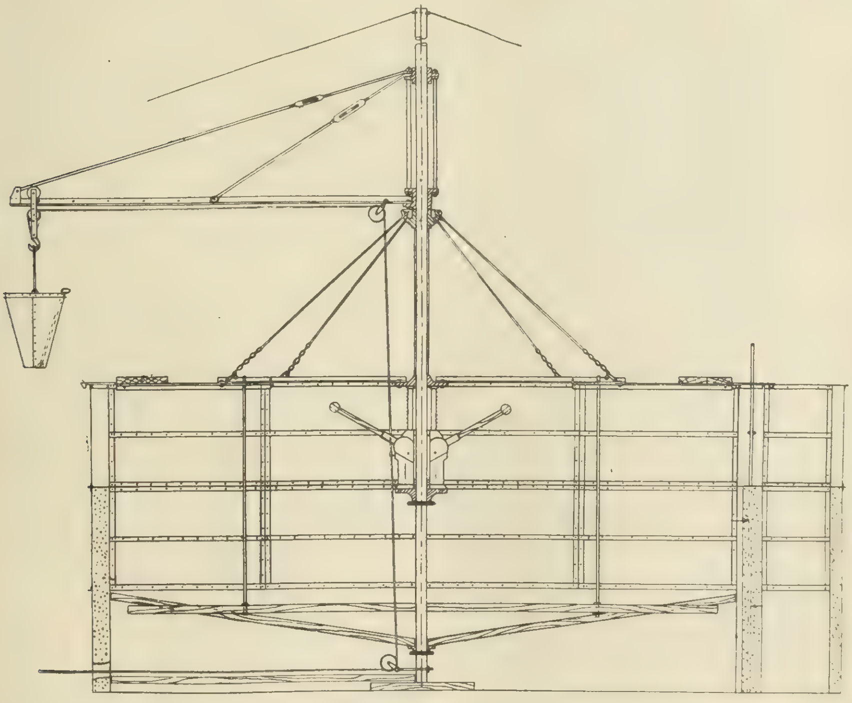


FIG. 3—DETAILS OF EQUIPMENT USED IN CONSTRUCTING THE COMBINED CONCRETE SILO AND WATER TANK AT HARTFORD, MICH.

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[1] Universal Portland Cement Co., Chicago

[2] Am. Steel & Wire Co., Chicago

[3] Conklin Constr. Co., Hartford, Mich.

the hoist was jacked up until it was above the floor line. The second scaffolding on the machine was left below the wooden floor forms, which were made of 2-in. x 10-in. plank set across the center and to one side of the center mast. The ends of the planks were set into the walls about 2″. A cleat was nailed to the 2-in. x 10-in. planks, 4″ from the top on each side. Several 2-in. x 4-in. planks were used as joists, being fastened to the 2-in. x 10-in. planks and projecting over the concrete wall about 2″. These joists were spaced about 2′ apart each side of the main joist and the lumber placed across the top of the joist to form the floor.

The forms for the roof were made of 2-in. plank with ½-in. lumber nailed on the edges of the plank to give the concrete cornice a depth of 4″. The cornice was held in place by brackets fastened in position on the outside of the wall by ⅜-in eye bolts running through the top of the wall and the 1-in. x 6-in. board bent around inside. The conical roof was made with 16 rafters equally spaced on the silo wall and meeting at the peak. The roof boards were placed on the rafters and pailed parallel to the silo wall.

CONCRETE WORK

The mixture for the structure was in the proportions of 1 part cement to 5 parts sand and gravel.

The concrete was mixed in a 3-ft. batch mixer[4] driven out by a 2½-h.p. gasoline engine.

The concrete was placed in the molds by means of a 3-ft. bucket made of No. 14-ga. black iron, reinforced around the top and bottom with 1½-in. x 1½-in. channel steel, as shown in Fig. 3. The bottom swings on two 4-in. hinges. The bail and the handle used to trip the bottom are made of ⅝-in. bar iron.

The bucket travels at the rate of 100′ per min.

It will be seen from Fig. 1 that one man is used on top to receive the bucket, and swing the boom around and dump the concrete. Another man or foreman handles the concrete in the forms.

It was not necessary to use a template in constructing the roof as a man accustomed to a trowel can get an almost perfect roof without such a device.

GENERAL FEATURES

It took one man two das. to dig the foundation which was about 4′ below grade line. About three hrs. were required to set up the Conklin equipment and four hrs. to fill the first section of the forms (3′ high and 6″ thick). The progress from then on was 3′ every half day or one ring, thus making 6′ or two rings per da. It required one-half da. to concrete the roof and a day's time to take down the machine and brush the silo inside and out with a cement wash, the outside being done with white cement.

The 3-in. pipe leading to the water tank was placed inside of the silo, about 3′ from the wall, and goes through the 8-in. concrete floor of the tank. Lock-nuts on the pipe and gaskets keep the water from leaking. The wool packing and the air-chamber also extend through the floor slab. The heat contained in the ensilage warms the air in the jacket, causing the warm air to travel to the top of the jacket and the cold air to descend, so that if the silo is only half filled with ensilage in zero weather, there will be no chance afforded for the water pipes to freeze, as there is a perfect circulation of air around them.

Folowing is an itemized cost of constructing the combined silo and water tank:

Wire mesh	$29.82
Twisted iron bars	9.00
74 bbls. of cement @ $1.35 per bbl.	99.90
Delivery of same at $.10 per bbl.	7.40
62 cu. yds. of gravel @ $1.15 per cu. yd.	71.30
2 das. excavating	4.00
Labor 7½ das. to set up machine and wall, 4 men	67.50
1 da. building forms put in floor	9.00
2 das. building roof	18.00
1 da. taking down machine and wash wall	9.00
1 da., 2 men putting in pipes for water tank	5.00
38′ of 1-in. pipe	3.04
Special clamp on pipe	.81
37′ of 3-in. pipe used as jacket over 1-in. felt	10.25
½-in. wool cover for 1-in. pipe inside 3-in. pipe	2.75
14 silo doors	14.00
Total	$361.77

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[4] Municipal Engrg. & Cont. Co., Chicago

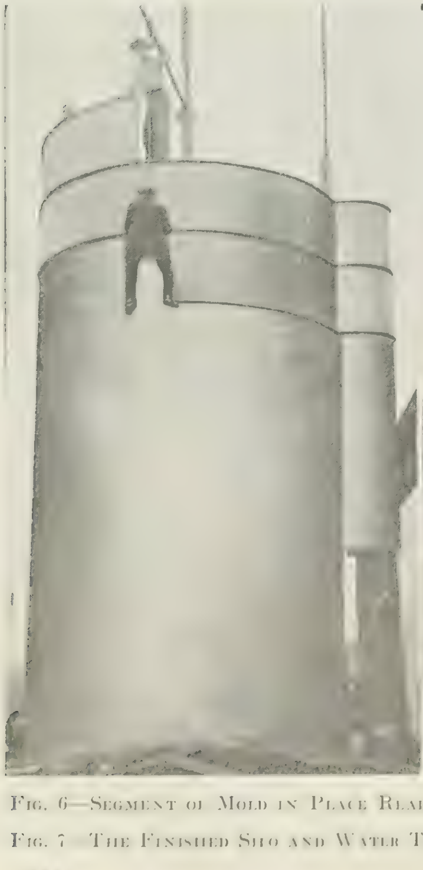


Fig. 6—Segment of Mold in Place Ready for Concreting

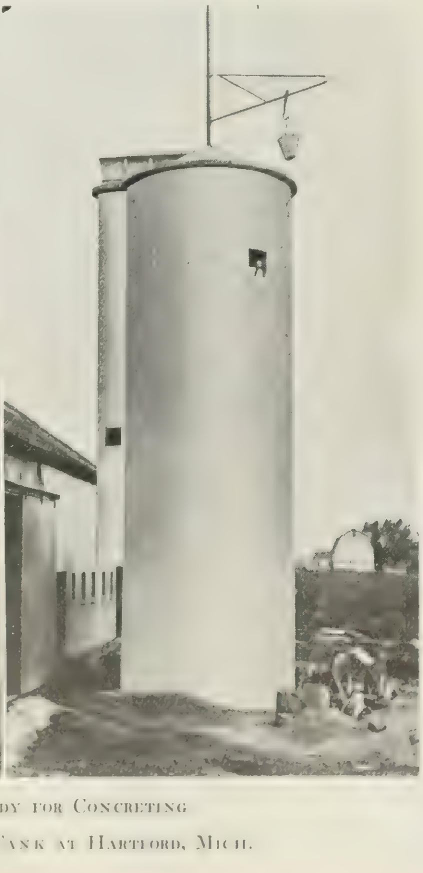


Fig. 7—The Finished Silo and Water Tank at Hartford, Mich.

Upon the principle of putting your best foot foremost, concrete doorsteps are stated by the *Worcester Telegram* to be the latest fad and well may this be said for there is nothing so discouraging and nothing so ill-looking as a broken down front step to a good looking house and yet how often this is seen all over the country and how simple it is to improve the appearance of the house permanently by making a concrete doorstep. In this way a favorable appearance is made to the purchaser and the concrete steps will be for all time a safe, permanent and pleasing entrance to the house itself.

All square column forms should have diagonal or beveled strips in the corners, unless the corners of columns are protected by metal strips; otherwise, they are liable to be chipped off. The beveled strips should run the full length of column forms, and should be nailed onto two opposite sides of the forms when they are made up.

New Equipment, Methods and Materials:
New Tools with Which the Industry Works □ □

This magazine will not publish "reading notices," so-called, for the benefit of advertisers. These pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers are constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.—THE EDITORS.

The Smith Non-Tilting Concrete Mixerette

The latest addition to the non-tilting line of Smith mixers, brought out to meet the demand which has manifested itself within the past two years for a light, portable and inexpensive concrete mixer of small capacity, is the Smith "Mixerette," shown in Figs. 1 and 2. It is said by the manufacturers, the T. L. Smith Co., Milwaukee, that the Mixerette holding 5 cu. ft. of dry sand, stone and cement, or 3 cu. ft. of mixed concrete, will produce 5 cu. yds. of mixed concrete per hr. The Mixerette is built on the same line as the well-known Smith Duo-Cone mixer.

In the Smith Mixerette are two features which stand out very prominently. The main drum ring and the driving pinion are entirely enclosed and protected from the finest particles of dirt or dust. The drum ring itself combines a large gear encircling the drum and two machined tracks. The dust-proof casing which covers the drum ring has two machined surfaces which snugly fit over the two machined tracks encircling the drum. This forms the bearing surface upon which the drum revolves. The sliding bearing eliminates main rollers and other supporting and driving mechanism, while the lower portion of the casing coming down to the truck sills forms a supporting pedestal for the drum.

The dust-proof casing is fitted with pressure grease-cups so that the machined surfaces can be kept cool and clean at all times. This excludes the dust and considerably increases the life of the mixer itself. This new feature will strongly appeal to the many contractors who have continually experienced trouble with their main roller tracks developing flat spots and the main rollers themselves rapidly wearing out, thus causing an uneven motion of the drum which wears out the driving pinion and at the same time causes great loss of power on the machine.

Another conspicuous feature of the Mixerette is the "ropeless" loader, the skip being raised by means of gears. There are no cables to break and no sheaves to get out of order, consequently none of the jerking, twisting motion of the ordinary pivot-

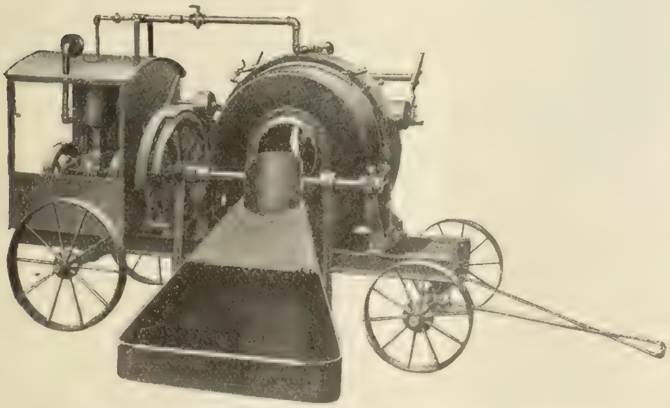


FIG. 1—THE SMITH MIXERETTE WITH CHUTE IN DISCHARGE POSITION

Three handles are provided so that the batch can be dumped from any point about the machine

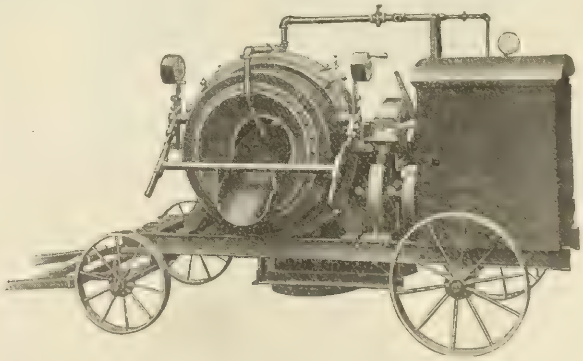


FIG. 2—THE SMITH MIXERETTE MOUNTED ON STEEL TRUCK WITH ENGINE, LOADER AND PIPE CONNECTIONS

ed hopper and no binding strain on the loader frame. It lifts easily and smoothly, being controlled by the jaw clutch and the brake. When the skip reaches its highest point, discharging into the drum, it strikes a projecting finger which automatically disengages the hoisting clutch, thus preventing any strain or damage to the hoisting mechanism.

The Smith Mixerette is operated by a high-priced hopper-cooled gasoline engine enclosed in a steel house.

The drum is equipped with three long, scoop-like blades which, in connection with the long, sharp angle discharge spout, give a very rapid discharge.

The equipment as shown herewith is light and durable, weighing only 2,500 lbs. For the contractor who does not want to invest the money in a power charger equipment as shown, this company furnishes the mixerette equipped with gated batch hopper. Such a rig weighs only 1,875 lbs. and with its low feed level of 3′ 10¼″ is an equipment likely to appeal to a great many building contractors having concrete work to do.

A New Type of Continuous Mixer

The old type of feeding device used on continuous mixers has been eliminated in the mixer shown in the accompanying illustration, being replaced by a system of chain elevators which forces the material into the mixing trough in a continuous stream.

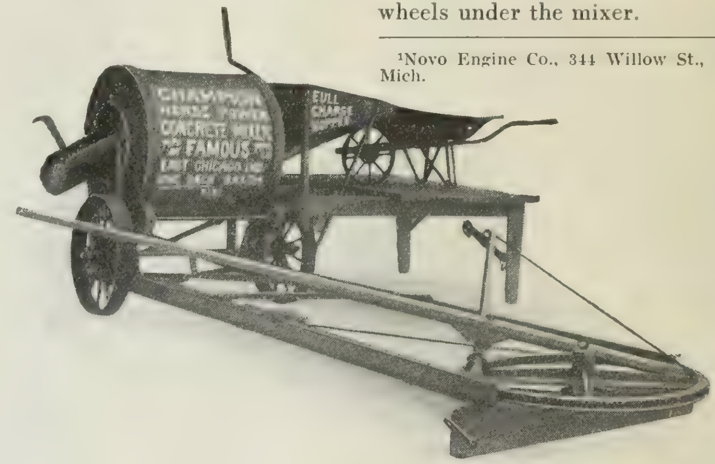
It is claimed that the mixer will feed in exact proportions whether the material be wet or dry. The proportioning and the mixing device are in plain sight, thus enabling the operator to see just exactly what the machine is doing.

The low down hoppers are said to eliminate a large part of the hard labor usually required in feeding a machine having elevated hoppers.

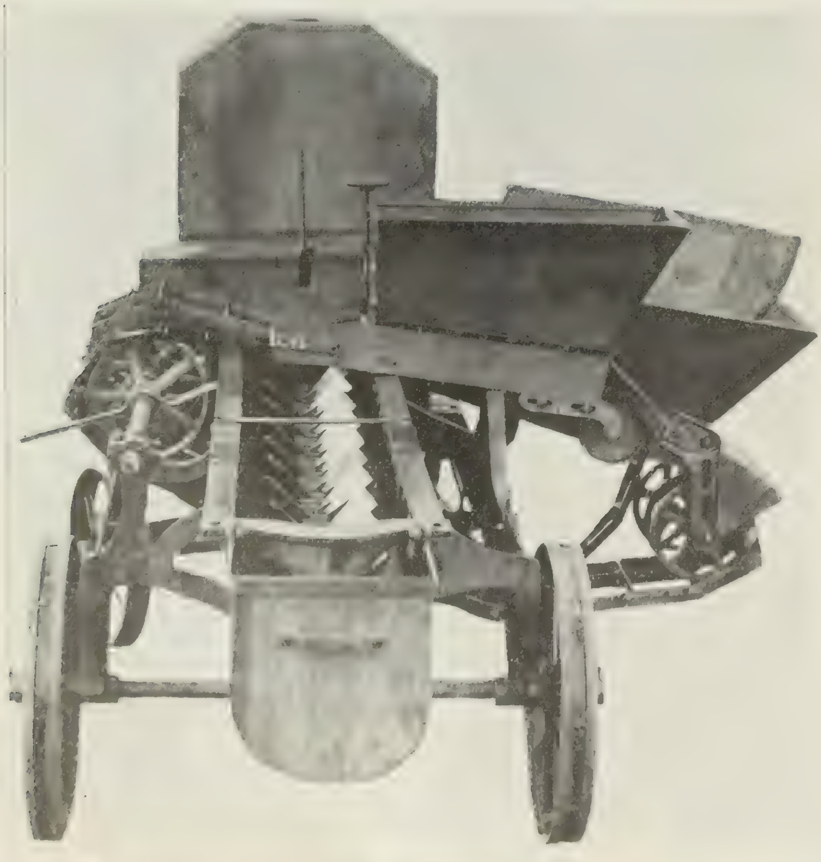
The continuous mixer has a capacity of from 3 cu. yds. to 12 cu. yds. per hr. and is equipped with a 4-h.p. Novo engine.[1] It is made by the Elite Mfg. Co., 100 Ohio St., Ashland, Ohio.

A Horse Power Concrete Mixer

The accompanying illustration shows the Champion horse-power one-sack batch mixer made by the Famous Mfg. Co., East Chicago, Ind. The construction of the apparatus is so clearly shown here that further description seems unnecessary, except to state that the machine may be readily moved by means of the two wheels under the mixer.



The Champion Horse-Power Concrete Mixer



The Elite Low-Down Continuous Concrete Mixer

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[1] Novo Engine Co., 344 Willow St., Lansing, Mich.

Trade Publications

The Little Wonder Cement Brick Mold—Raber & Lang Mfg. Co., Kendallville, Ind., paper, 6¼″ x 3¼″, 8 pp., illust. The construction and use of the Little Wonder brick molds are fully covered in this interesting folder.

Enduring Concrete—The Pettyjohn Co., Terre Houte, Ind., paper, 9¾″ x 12″, 16 pp., illust. This booklet deals with ornamental concrete for the home, for the lawn and for the garden, concrete columns and balustrades, piazzas and pergolas, vases and flower boxes, steps and buttresses, garages and artistic illuminating standards. It is well illustrated and neatly arranged.

Thomas Reversible Single Drum Electric Hoist—Class "B," Bulletin No. 128—Thomas Elevator Co., Chicago, paper, 12″ x 9″, 4 pp., illust. This bulletin contains a description of the mechanical construction of the Thomas reversible drum electric hoist.

The Detroit Testing Laboratory—The Detroit Testing Laboratory, Detroit, paper, 10″ x 4½″, 20 pp., illust. This booklet is intended to give a better idea of this institution and a fuller conception of its various lines of endeavor.

Yarns—American Mfg. Co., Brooklyn, N. Y., paper, 8″ x 5¾″, 20 pp., illust. This house organ contains an interesting article on "The Transmission Rope Splice" taken from the Blue Book of Rope Transmission. It is well edited and neatly arranged.

Concrete-Cement Age

Vol. 6 *Detroit, April, 1915* *No. 4*

Building Regulations

A BUILDING code is primarily for the protection of the public. The average citizen lacks the special knowledge to make him competent to judge between good materials and poor materials and between good design and bad design. Incidentally, a good building code protects the manufacturers of good materials and the contractor with skill and honest motives, from manufacturers of inferior materials and from contractors who are either ignorant or dishonest, or both. The intended effect, then, of well considered building regulations is quite simple and desirable and nobody whose opinion is worth while can object to them. Such regulations benefit everybody who deserves to be benefited. It is obviously to the advantage of builders and manufacturers of building materials to make special efforts toward the adoption of suitable building regulations in every community.

The errors come simply because building regulations are formulated and adopted by human beings in whom error is common. While it is best to be sure that the public is amply safeguarded, it is of great importance that justice does not lean backward is trying to stand too straight. If the public is prevented, by the ignorance or biased views of the framers of the regulations, from the fullest possible use of good materials and legitimate methods, then the resulting injustice is different in minor degree only, and not at all different in kind, from the injustice of regulations which are too feeble in their provisions for safety.

Freezing and Thawing Concrete

IN connection with the recent collapse of the Shust Bakery building at Saginaw, Mich., an interesting fact is brought out so far as the concrete is concerned. It was demonstrated by laboratory test many years ago that no damage is done by the freezing of concrete, when the material is permitted to remain for a long time in a frozen condition and is then thawed, and the hardening permitted to continue. This has been proven by practical results with concrete work construction in the Northwest under the coldest temperature conditions. On the other hand, the same series of experiments demonstrated that concrete once frozen and permitted to thaw and again to freeze and thaw again and freeze again would ultimately lose all its strength. The Shust building collapse is rather a remarkable proof of this fact and conveys a warning to many building contractors doing work in varying climatic conditions. The original concrete which failed was poured Nov. 13 and 14, 1914, for the columns and spandrels and that for the roof 10 das. later. At that time no precautions were taken or considered necessary to protect the concrete. Nov. 8, 9 and 11, the temperatures were from 27° F. to 32° F., from Nov. 12 to 15 there were rain and a small amount of snow, with temperature varying from 33° F. to 52° F. Nov. 16, the temperature went below the freezing point and continued until Nov. 24 and 25, getting as low as 15° F. Nov. 18. The forms were removed about the middle of Jan. and the roof and columns were unsupported until the time of the failure at 6 a.m. Feb. 11. The temperature from Jan. 10 to Feb. 10 was below freezing and at 9 p.m. Feb. 10, the day before the collapse, the temperature rose above freezing point and continued above until the time of the failure. At that particular time the building was heated by steam from the interior.

The record of this case seems to be so clearly a case of freezing and thawing mortar as almost to corroborate in a large way the experiments made by the Baltimore & Ohio R. R. in Philadelphia in the early 80's and all the series of experiments on freezing and thawing mortar which have been appearing in recent scientific publications. The danger seems to be the exposure of mortar to varying conditions of temperature and certainly the record of this case seems to prove the seriousness of the difficulty to be apprehended.

Water in the Mix

THE amount of water required to produce any particular plasticity or consistency in concrete varies so greatly with the proportions of the ingredients; the kind and fineness of the cement; the character, porosity and dampness of the aggregate; temperature or weather conditions, etc., that it is almost impossible to give any hard and fast rules. In fact, it is not customary to specify the amount of water to be used unless the proper consistency and the amount to be required therefor have been previously determined by trial with the materials to be used. Even if the materials were all supplied under the same uniform conditions, the same volume of water would not produce from each batch a concrete of uniform consistency because as the concrete is laid the water works up through from one layer to the next, so that more water may be necessary early in the morning than later in the day. It is desirable, nevertheless, to regulate closely the amount of water per batch, as better results can thus be secured.

Mile-A-Minute Concrete Work

A RUSH job out in Ohio required some novel expedients to secure desired results. A 3 p.m., Jan. 9, a contract was awarded for the erection of a one-story structure 90′ x 202′ in size, with two monitors, for an acid building for a storage battery company. It was stipulated that the building should be completed by Feb. 1. Considerable concrete was involved and on account of this and to guard against the effects of adverse weather, a circus tent 150′ x 350′ was put over the site. Construction was begun at 6 a.m., Jan. 10, with a force of 250 men and in 16 das. the entire job was completed, thus enabling the lucky contractor to establish a construction record for "dead-of-winter" work. Not only is the ingenuity of using a tent to make speed possible in construction to be highly commended, but so far as the construction itself is concerned, the advantages of uniform temperatures in winter concrete construction cannot be overestimated.

Shifting Sands

FLOORS and sidewalks are among the earliest of the modern works in concrete. And for all that one of the most important discussions at the American Concrete Institute Convention was on floors—how to prevent dusting. At least it appears to be fairly settled that fine material must be absent from the top course. Fairly coarse, hard stone or sand (none of it passing a 30-mesh screen) is recommended and hard stone has the preference over sand. It is not wise to consider even the apparently simple problems as finally solved. Somebody is sure to find a better way.

Concrete Under the Microscope

AN entirely new aspect of the varying quality of concrete is presented by Nathan C. Johnson. Mr. Johnson uses a microscope to find the holes and the unhydrated cement. He has contributed interesting discussions of his findings to recent issues of the *Engineering Record* and he addressed the American Concrete Institute on the subject, illuminating his remarks with lantern views from micro-photographs. In these investigations, there are two impressive observations: of the real density of concrete and the extent to which unhydrated cement is present. It seems that a comparatively small part of the cement content in concrete actually performs its function, and much less cement might safely be used if all which is used actually assumed its share of the binding function.

The Pyramids and the Douglas Fir

IN discussing the importance of lightness in building construction, Charles E. Fox, Chicago architect, told the American Concrete Institute Convention how we had come a long way from the Pyramids to the modern steel frame building, yet he pointed out that the works of human genius are still very far from the achievement of Mother Nature who produced the Douglas Fir and the Stalk of Rye. These are real wonder works in the way of combined strength and lightness.

Changes in Editorial Staff

JEROME COCHRAN, C. E., has resigned his position on the editorial staff of "Concrete" and will enter the contracting field in Houston, Tex. Mr. Cochran will continue the special articles which have been appearing under his name in these pages.

C. D. Gilbert, Newton Highlands, Mass., has joined the editorial staff of "Concrete" in the capacity of Associate Editor. Mr. Gilbert has been actively engaged in concrete construction and is familiar with many of the problems of the man on the job.

A bottomless box for a 1:2:5 mixture in which two bags of cement are to be employed, may have the sandbox 2′ x 2′ x 11½″ inside measurements, while the broken stone or gravel box should be 2′ x 4′ x 11½″. For other combinations the necessary size of boxes is obvious from these measurements.

Care should be taken to see that wheelbarrows, dump carts, or whatever conveyances for the concrete material are to be used, have easy access to the mixer, and the mixer located as near the place of concreting as practicable.

Wire ties may be used to secure forms against pulling apart. They may be wound around opposite studs and then twisted with a stick as a turnbuckle until the studs are the proper distance apart. To remove the forms the wires are cut and then trimmed very close to the concrete surface.

Concrete-Cement Age

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC.
CONCRETE-CEMENT AGE

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Roy Marshall, 27 La Salle Gardens, North, Detroit.
Allen V. Brett, Chicago, Ill.
There are no bonds, mortgages or other securities issued.

(Signed) WALTER C. BOYNTON,
General Manager.

Sworn to and subscribed before me, a Notary Public in and for the County of Wayne, State of Michigan, this twenty-fourth day of March, A. D. 1915.

ROY MARSHALL,
Notary Public.

(My commission expires Feb. 3, 1917.)

Surface Treatment of Concrete Bridges for Railway and Highway Traffic

By Albert M. Wolf, C. E.[1]

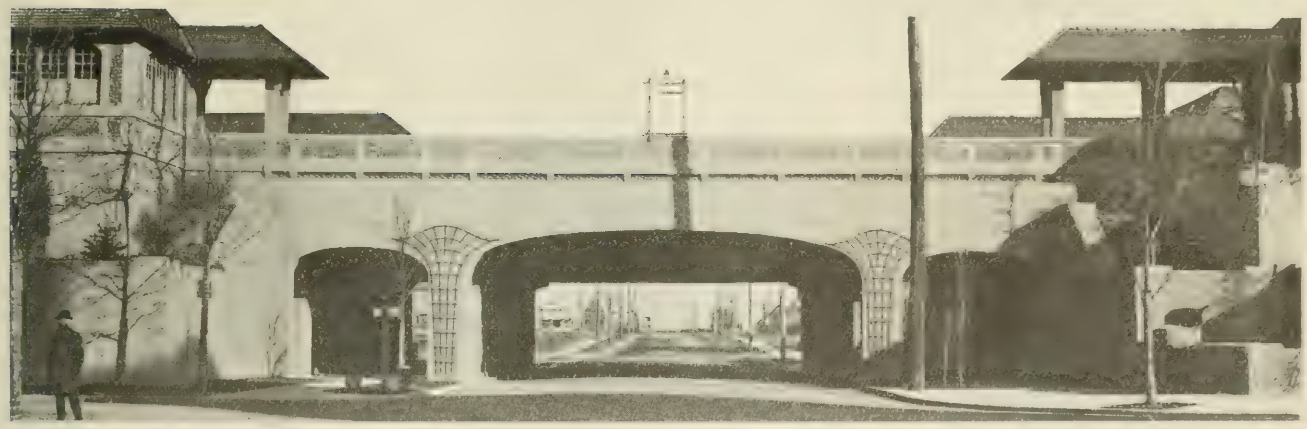

Fig. 1—Continental Ave. Bridge, Forest Hills, N. Y., Long Island R. R. Stucco on Concrete

This article describes in detail, with illustrations, the methods of surface finish employed on several bridges in various parts of the country.

The structures illustrated and described herein give a very clear indication of the popularity of certain methods of surface finish for bridges and give some idea of the artistic possibilities of concrete. It is gratifying to note that at the present time so much attention is being paid to the surface treatment of railroad bridges; the railroads seem to have become imbued with the spirit of the times which is tending toward the artistic as well as the utilitarian in bridge design.

Artistic bridges of steel are costly and therefore quite rare in this country; concrete, however, has solved the problem of artistic design because of the ease with which it lends itself to esthetic designs. Concrete bridges can be molded with pleasing lines at a slight increase in cost over a structure with plain, straight lines, and this, in a measure, accounts for their popularity.

CONTINENTAL AVE. BRIDGE, LONG ISLAND R. R., FOREST HILLS, N. Y.

The Continental Ave. track elevation bridge at Forest Hills on the Long Island R. R. is an interesting example of the possibilities of the architectural treatment of a plate girder structure by masking it with a concrete portal of special decorative design.

The structure as first built consisted of deck plate girder spans with ballasted floor carried on steel columns at the curb lines and plain concrete abutments at the street lines. The roadway spans are 40′ and the sidewalk spans 20′. To make this structure, with its plain and simple outlines, harmonize with surrounding structures, almost entirely of concrete, Grosvenor Atterbury, the architect for the Sage Foundation Homes Co., at Forest Hills Gardens, selected the scheme shown in Fig. 1.

The treatment consists mainly of a false arched screen or portal of concrete with three arches of small rise, with a passenger platform support built in front of the plate girders. The plane of the arch faces is 13′ out from the center line of the outer girders and the rise of the arch is such as to expose a considerable portion of the girders below the intrados of arches. The effect of the arched portal, however, is not interfered with since the high light on the arch faces makes them so pronounced that the horizontal line of steel work 13′ back from the face is scarcely noticeable.

The stucco facing of the portals contains a considerable percentage of broken bits of red roofing tile which produce a warm pinkish tone, distinctly more pleasing to the eye than the cold gray tint of ordinary concrete. A much smaller percentage of the broken tile would be sufficient in ordinary work to relieve the dead gray surface. The proportions used in this work were as follows: 1 cu. ft. of cement, 1 cu. ft. of sand, $\frac{1}{3}$ cu. ft. of $\frac{1}{4}$-in. broken tile and $1\frac{1}{2}\%$ by weight of black oxide.

The projecting parapet with the small brackets under the concrete posts in the hand rail with brick panels and concrete top rail adds much to the beauty of this structure, which presents a unique solution of the problem of converting an ugly bridge into one of graceful and harmonious outline.

THE MORRIS TURNPIKE ARCH AT HOPATCONG, N. J.—D. L. & W. R. R.

The Morris Co. turnpike arch on the new Slateford-Hopatcong cut-off of the D. L. & W. R. R., is a fine example of the simple but very effective surface treatment to be obtained by rusticating or scoring the exposed surfaces, as shown in Fig. 2.

The bridge is a three-track structure of 40-ft. skew span with a reinforced concrete arch ring and plain concrete abutments, wing walls and spandrels. Concrete of a 1:3:5 mixture was used in the arch ring and for all plain concrete work except the coping where a 1:2:4 mixture was used. All concrete of exposed sur-

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[1] Prin. Asst. Engr., Condron Co., Chicago

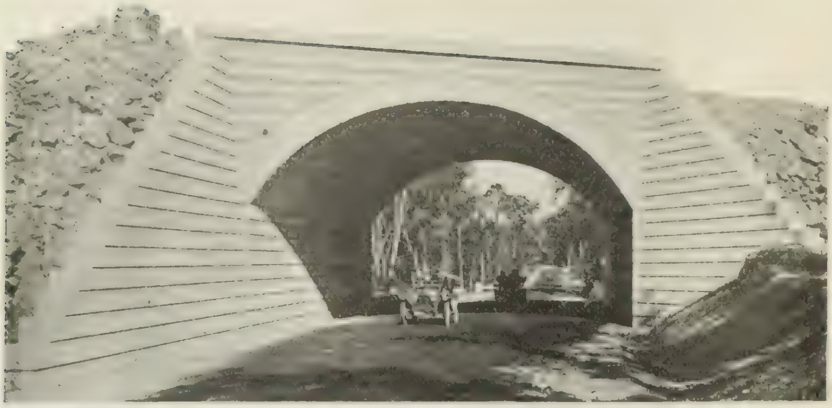

FIG. 2—MORRIS COUNTY TURNPIKE ARCH, HOPATCONG, N. J. D. L. & W. R. R.

Rusticated concrete surfaces

faces was carefully spaded when placed in the forms so as to obtain a uniform surface, free from voids. All exposed faces of parapets, abutments and wing walls have horizontal V-shaped coursing joints or scorings about 1′ 8″ centers. The extradosal line of the arch ring is delineated by a similar false joint and the face of the arch ring is marked off into voussoirs or ringstones on radial lines extending back for a short distance on the soffit in lines normal to the face. The date plate at the crown is so molded as to form the keystone of the arch. The coursing joints are 2″ deep, 2½″ wide at the face and ⅜″ at the back, formed by nailing beveled strips to the forms. All horizontal construction joints were made at points where strips were placed so that in no case would they be very noticeable on the surface.

It cannot be denied that the appearance of this structure is greatly improved by the method of surface treatment employed. The rusticated surface effectually hides all horizontal construction joints, breaks up the monotony of the plain surface and renders the form marks practically unnoticeable. The cost of the structure was increased very little by this rusticating of the surface, while the beauty of the bridge was greatly enhanced.

OVERHEAD HIGHWAY ARCH AT SOUTH PARK, FALL RIVER, MASS.

A reinforced concrete highway arch bridge over the tracks of the N. Y., N. H. & H. R. R. R., at South Park, Fall River, Mass., completed in 1912, is notable for its excellent appearance due in a measure to the method of surface treatment. This arch over three tracks has a clear span of 82′ 6″ with an actual rise of 9′ 2″ and an apparent rise of 14′ 10″, as shown in Fig. 3.

The spandrel walls, plain concrete, gravity sections are finished off with a corbeled coping and a paneled handrail of reinforced concrete. The abutments are of plain concrete with straight wings. The roadway is of brick on a concrete base and is 25′ wide, flanked on either side by two 8-ft. sidewalks.

The soffit of the arch was rubbed with carborundum[2] stone after removing forms, and any voids found were grouted so as to leave the concrete with a smooth surface.

All exposed surfaces of the bridge have a 1:2 mortar surface finish, placed at the time of pouring concrete by means of iron facing plates placed about 1″ from the forms and moved up as concreting progressed.

The balustrade posts and rail inside and out, spandrel walls—except the triangular panels—the exposed parts of the arch ring, wing walls and abutment faces below the springing were finished as follows:

After removing the forms the concrete was thoroughly washed off with a brush and rubbed with a coarse No. 16 carborundum stone, bringing the surface to a lather. After the rough projections were removed the lather was washed off with a brush, the concrete again wet down and dusted with a 1:1 dry mixture of cement and sand. This mixture was rubbed into the surface with a No. 16 carborundum stone, care being exercised not to allow any mortar to remain on the surface. The final rubbing was then done with a No. 30 or fine carborundum stone.

The triangular inset panels in the spandrel walls at either side of the crown between the extrados of arch ring and spandrel coping and the handrail panels were bush-hammered when the concrete had become quite hard. This treatment affords a very pleasing contrast to the rubbed surface of the rest of the structure.

Fig. 3 does not display as well as it might the excellent results obtained by the combination of these two methods of surface finish for concrete structures. The beauty of the bridge can, however, be readily seen.

THE YARDLEY BRIDGE, PHILADELPHIA & READING RY.

The surface treatment employed on the new double track arch bridge of the P. & R. Ry. over the Delaware river at Yardley, Pa., is especially good and is worthy of note because of the rather unusual method of obtaining the finish.

The bridge, completed in 1912, is 1,445′ 6″ long, composed of 11 arches of 90′ 9″ span and three arches of 85′ 11″ span, as shown in Fig. 4. The width of the structure is 36′ and the height is 70′ above mean low-water level. The arch rings of reinforced concrete are of the five-centered type with a rise of 35′ and a crown thickness of 3′ 6″.

The projecting pilasters above the piers are paneled and marked off into horizontal courses by triangular grooves or scorings. The arch rings are divided into false ringstones in a similar manner and the spandrels above the rings have triangular inset panels.

All showing faces of the structure except the concrete railing posts were spaded while the concrete was being placed. The posts were bush-hammered after the concrete had become quite hard. The forms were lined with sheet metal and the spading against these produced a very smooth and uniform surface. The original specifications contemplated a granolithic finish throughout, this

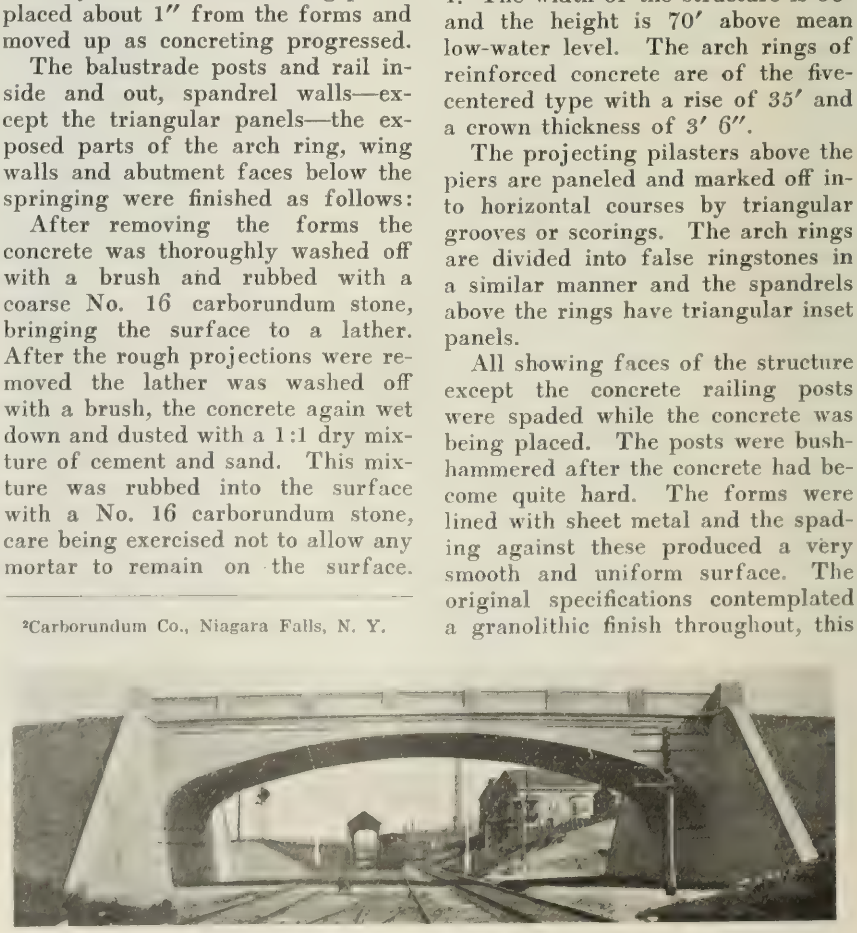

FIG. 3—OVERHEAD HIGHWAY ARCH, FALL RIVER, MASS.

Rubbed and bush-hammered concrete surface

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[2] Carborundum Co., Niagara Falls, N. Y.

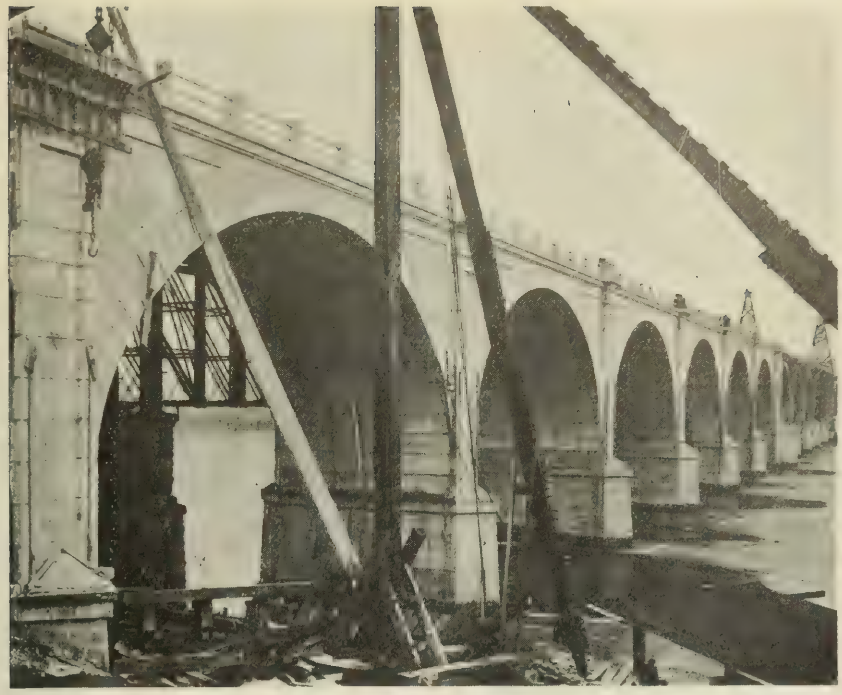

FIG. 4—DELAWARE RIVER BRIDGE AT YARDLEY, PA. PHILA. & READING RY.

Spaded and rusticated concrete surfaces

surface to be scrubbed and washed so as to expose the particles of granite in a uniform manner, or bush-hammered—the choice between these two methods of finish being left to the contractor. The contractor preferred and was granted permission to use metal lined forms and to spade the faces, at the same time agreeing to produce a finish equal to the granolithic in all respects. From Fig. 4 it appears that the finish obtained was entirely satisfactory to the railway company.

The general appearance of the structure is greatly enhanced and rendered more pleasing by the simple decoration of the surface by rusticated joints or scorings.

INDEPENDENCE BOULEVARD BRIDGE, B. & O., C. T. R. R., CHICAGO

The Independence Boulevard track elevation structure of the B. & O., C. T. R. R. at Chicago is one of the finest structures of its kind in the city. This bridge—a steel structure with concrete portals—spans one of the finest boulevards of the West Chicago Park System, and was designed and executed with the one idea in mind that it should add to, rather than detract from, the beauty of the boulevard. About 15 different designs were studied before one was found which the railroad company saw fit to present to the Park Board. This design, the one after which the structure was built, met with the unanimous approval of the Board and it is safe to say that they have not regretted the selection. It is partly shown in Fig. 5.

The bridge is a four-track structure, 250′ long, consisting of nine spans of five longitudinal plate girders carried on steel columns and plain concrete abutments. The roadway spans near each end of the bridge are of 35-ft. span; the intermediate or parkway spans are of 25′ 7″ centers; the east end span (right end in Fig. 5) over sidewalk is 24′ 6″ and the span over west walk is 31′ 6″ c. to c. The concrete bridge floor is carried on transverse steel beams.

The exterior girder spans are encased in concrete so as to give the appearance of a masonry structure of nine arches of comparatively flat rise, with massive but simple and artistic treatment of portals.

The roadway arches are the largest and of greater rise than the others and, quite properly, the most ornate. The columns or piers of the roadway arches project about 16″ beyond the face of arch with sloping buttresses projecting about 3′ beyond the main portion. The main part of these buttressed piers or pylons is carried up to some height above the top of arches and is finished off with a projecting concrete medallion. The sloping concrete coping merges with a projecting medallion above the crown of arches

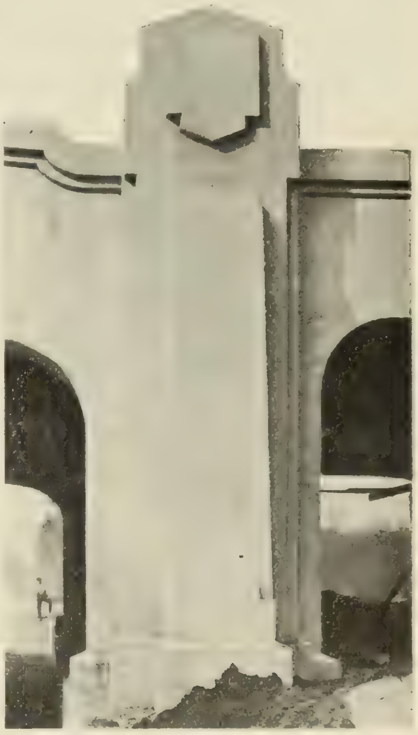

FIG. 6—DETAIL OF PIER—INDEPENDENCE BLVD. BRIDGE, SHOWING CHARACTER OF SURFACE

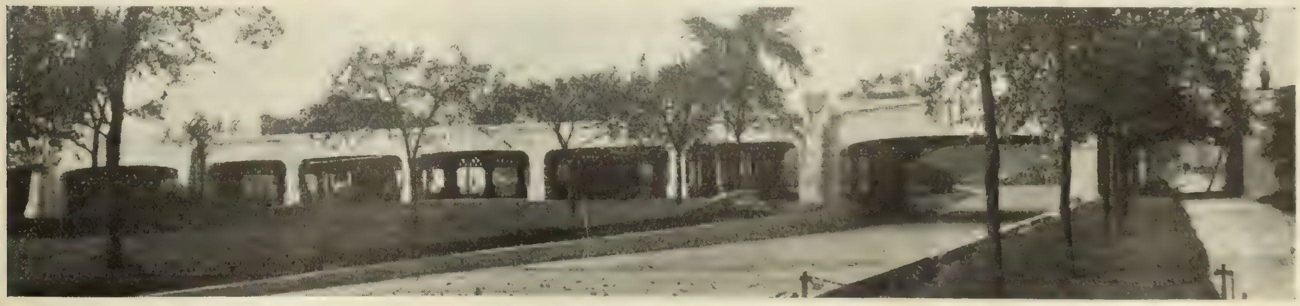

FIG. 5—INDEPENDENCE BLVD. BRIDGE, CHICAGO. B. & O., C. T. R. R.

Rubbed concrete surfaces

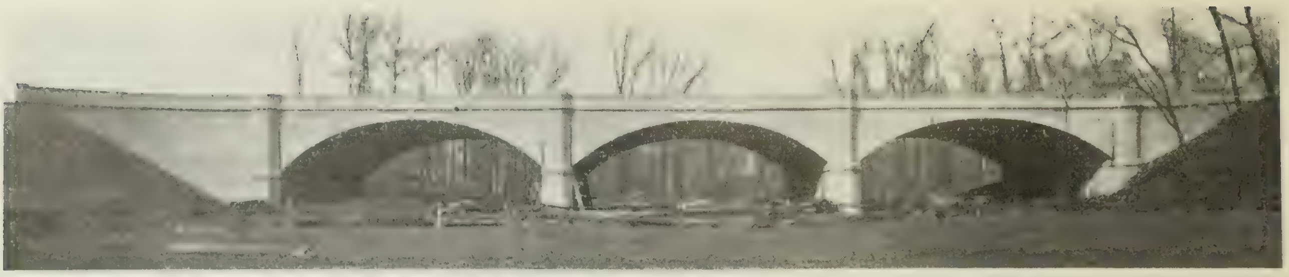

FIG. 7 TACONY CREEK ARCH BRIDGE, PHILADELPHIA

Scrubbed and rusticated surfaces with dark shade aggregate exposed

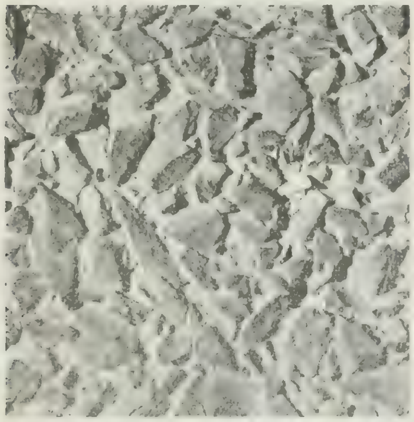

FIG. 8 SURFACE FINISH OF CONCRETE — TACONY CREEK ARCH (SEE FIG. 7). FULL -SIZE VIEW

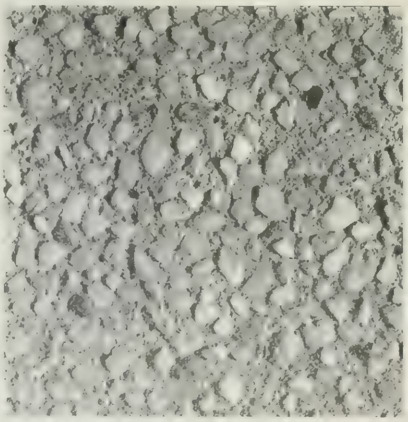

FIG. 10 SURFACE FINISH GRAVERS LANE BRIDGE (FIG. 9) SHOWING CHARACTER OF SURFACE (FULL SIZE)

which is of more elaborate design than those on the pylons.

The arches of the sidewalk and the parkway spans have a rise of only 3″ above the tops of fillets of 2-ft. radius at the columns. A coping of the same detail as that on roadway spans is used on these spans but is carried across the spans with a level top. The steel columns encased in concrete are 2′ x 2′ and unornamented.

The concrete used for this work was a mixture of 1 part cement and 5 parts of crushed limestone varying from ½″ to dust, no sand being used. All edges and corners of concrete were given a ¾-in. bevel. The steel girders and columns were wrapped with a No. 28 triangle mesh,[3] to furnish a positive bond for the concrete and to prevent expansion and contraction cracks.

Although no special mortar facing was used, a fine surface, free from stone pockets, was obtained by thoroughly spading the concrete next to the forms at the time of placing, and using a stone aggregate varying from ½-in. size to dust. After the forms were removed and the concrete has seasoned and hardened to some extent the form lips and ridges were chipped and filed off with chisels and coarse rasps. The surface was then wetted thoroughly and rubbed with a coarse carborundum brick until the surface was fairly smooth; then a thin wash of cement and sand was applied and allowed to harden. The final rubbing was done with a fine carborundum brick until all of the cement wash had disappeared and the surface was as smooth as possible. All concrete, including the abutment faces, was treated in this manner. This finish is fine-grained, rendering the concrete more nearly impervious, and has a much lighter color—grayish white—than can be obtained by any other method with the same materials. Fig. 6 shows the details of one of the buttressed pylons. It is of interest to note that the cost of ornamentation of this bridge—250′ long —was much less than that of the Ogden Ave. Viaduct hereinafter described, which is only 135′ long.

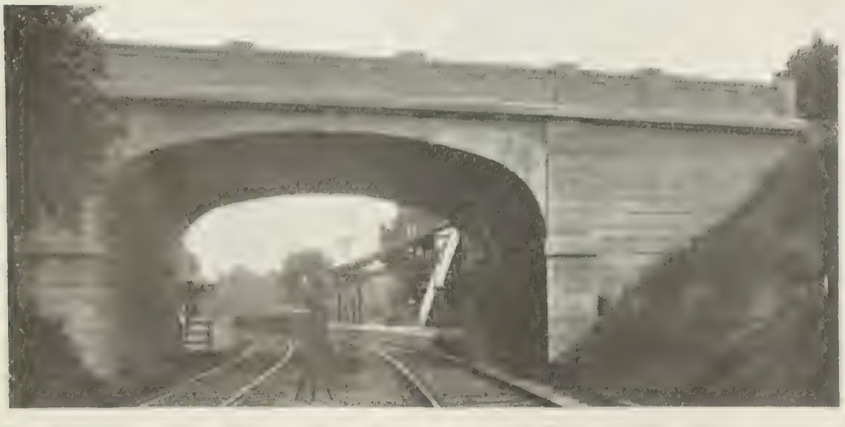

FIG. 9 GRAVERS LANE BRIDGE OVER PHILADELPHIA & READING RY., PHILADELPHIA

Scrubbed and rusticated surface with small pebbles exposed

The beauty of this bridge was not attained by the use of a great deal of ornamentation and paneling, but by the simple corbeled coping, the buttressed pylons, the smooth rubbed concrete surface and the symmetry and balance of proportion of the structure as a whole.

TACONY CREEK ARCH BRIDGE, PHILADELPHIA

The Boulevard bridge over Tacony Creek and Ashdale St., Philadelphia, built in 1908, is notable for its splendid surface finish. This bridge, consisting of three segmental arches of 80′ in clear span, is 100′ wide and designed for highway traffic only (see Fig. 7). All parts of the structure except the parapets are of rubble concrete without reinforcement of any kind. The parapets are of reinforced concrete.

The arch rings are marked off into false voussiors of ringstones by V-shaped grooves, while the pier abutment and spandrel surfaces have horizontal coursing grooves formed by nailing triangular beads to the inside of forms. The curved wing walls and projecting bastions over the piers surmounted by an ornamental concrete handrail of pleasing design add greatly to the appearance of the structure.

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[3] Am. Steel & Wire Co., Chicago

The full-size reproduction of the surface finish (Fig. 8) shows very clearly the excellent texture obtained. The coarse aggregate is a dark shale stone screened to the size generally used for roofing. The method used in obtaining this finish is given briefly in the following:

All showing faces have a granolithic facing composed of 1 part cement, $1\frac{1}{2}$ parts coarse sand or gravel, and $2\frac{1}{2}$ parts granolithic grit, mixed into a stiff mortar. This granolithic grit consisted of a dark shale stone passing a $\frac{3}{8}$-in. sieve. This mixture was deposited by skilled workmen against the vertical face forms to a thickness of at least 1″ at the same time as the concrete backings so as to form an integral part of the work, care being taken to prevent air-pockets or voids in the surface. The face forms were removed as soon as the concrete had sufficiently hardened and any voids were filled with the same mixture. The surface was then scrubbed with brushes and water until the grit was exposed, then rinsed clean and protected from the sun and kept moist for 3 das. Bridge seat courses and other horizontal surfaces were surfaced with the same granolithic finish to a thickness of at least $1\frac{1}{2}''$ immediately after the concrete was tamped and before it had set. The facing was then troweled to an even surface and after it had set sufficiently hard it was washed until the grit was exposed.

All horizontal construction joints were made at the apex of a triangular coursing bead so as to hide effectually the otherwise unsightly joints between successive sections. The concrete balustrades were cast in iron molds and upon their removal the surfaces were scrubbed and then immersed in clean water for 5 das. before erection.

The combination of the rusticated joints and the scrubbed surface exposing the granolithic aggregate forms a very pleasing treatment, the general character of the surface being dependent upon the kind of aggregate used.

GRAVERS LANE BRIDGE OVER CHESTNUT HILL BRANCH P. & R. RY., PHILADELPHIA, PA.

The Gravers Lane Bridge, Philadelphia, Pa., built in 1905, is perhaps one of the earliest structures the surface finish of which received more than ordinary attention. This reinforced concrete arch of 38′ clear span is a highway structure with a width of 50′ (see Fig. 9). The arch ring is rather flat, being a three-centered arch with a central portion of large radius in order to obtain the necessary clearance over the railroad tracks.

The arch ring is divided into false voussoirs and the spandrels and abutments are relieved by horizontal coursing joints. The handrails or parapets are solid concrete walls with inset panels.

Fig. 10 gives an excellent idea of the appearance of the surface finish of this structure. This finish was obtained in the same manner as described in detail for the Tacony Creek bridge, the only difference being the coarse aggregate of the facing mortar, which in this case consisted of small pebbles.

The general appearance of the structure is very pleasing, due in the most part to the surface finish.

OGDEN AVE. VIADUCT, B. & O., C. T. R. R. CHICAGO, ILL.

The Ogden Avenue viaduct of the B. & O., C. T. R. R., is a structure upon which a type of surface treatment entirely different from those previously described, was used. The bridge is a steel plate girder structure—135′ long between abutments—the portals of which are encased in concrete and decorated with red, blue and yellow Moravian tile, without paneling or other ornamentation, as shown in Fig. 11. Curved abutments with ornamental concrete lamp-posts at the ends are other architectural features of the bridge. Two more lamp-posts are placed at about the third points of the structure over the roadway columns. The lamp-posts were cast in plaster molds, the coarse aggregate used being a crushed granite. After the removal of molds the surfaces were washed with dilute muriatic acid and scrubbed with fibre brushes to expose the aggregate.

The concrete mixture used for the portal was composed of 1 part cement and 4 parts of crushed limestone graded from $\frac{1}{2}$-in. size to dust. When the forms for the fascia girders were built small blocks of wood were nailed to the forms wherever the tile was to be placed. These wooden blocks were made of the same shape as the tile inserts which were to replace them, and were about $\frac{1}{8}''$ larger than the latter. After removing the forms the tile blocks were set in place with cement grout and the entire surface washed with dilute muriatic acid and scrubbed with fibre brushes.

Although the general appearance of the structure when viewed from a distance is good, it cannot be said that the treatment is all that could be desired when seen at close range. The cement grouting used in setting the colored tile has cracked a great deal and rendered these portions rather unsightly. This seems to be the main fault with this type of architectural treatment, which is more expensive than any other method herein described. Wherever a rich cement grout or mortar is used on a concrete of leaner mixture there is sure to be trouble from cracking of the mortar on account of its relatively great shrinkage, and it is therefore best not to use cement mortar on concrete in any kind of decorative treatment.

CEDAR AVE. BRIDGE, CLEVELAND SHORT LINE RAILWAY, CLEVELAND, OHIO

The Cedar Ave. track elevation bridge on the Cleveland Short Line Ry. is a two-span plate girder bridge encased in concrete to give the appearance of two arches of flat rise, as shown in Fig. 12. An ornamental balustrade or parapet wall hides the tops of steel girders. The abutments are of plain concrete, paneled to harmonize with the remainder of the structure. The exposed surfaces of concrete were rubbed with carborundum bricks until a uniformly smooth surface was obtained.

In the track elevation work of this railway many other bridges were built and the methods of surface fin-

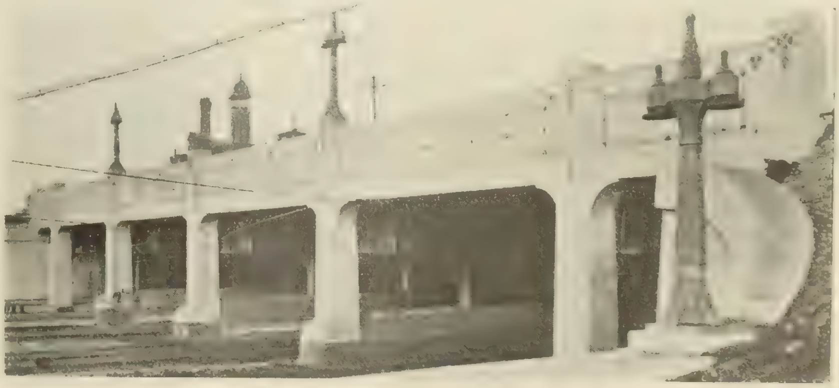

FIG. 11—OGDEN AVE. VIADUCT, CHICAGO, ILL. B. & O., C. T. R. R.
Surface decorated with colored tile

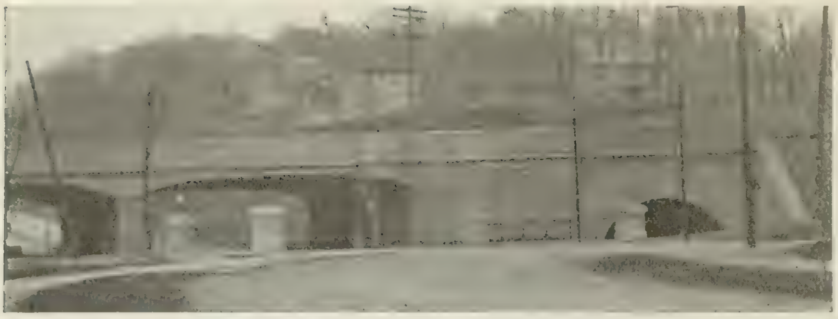

FIG. 12—CEDAR AVE. BRIDGE, CLEVELAND, O. CLEVELAND SHORT LINE RY.

Rubbed and paneled concrete surface

ish used were quite varied. Some of the methods employed are given in the following which is abstracted from a paper by A. J. Himes, Engr. of Grade Elimination, C. S. L. Ry., in *Bulletin* No. 160, Am. Ry. Eng. Assn.

Particular pains were taken to remove all form marks and other defects from the surfaces of concrete. The cheapest method and, in general, the most satisfactory, was to bush-hammer the surfaces. Such work cost about 4 cts. per sq. ft. while rubbing with carborundum bricks cost from 4 cts. to 10 cts. per sq. ft., depending upon the character of the surface.

In order to retain good surface appearances all laitance must be removed from the tops of all layers of concrete. The deposition of laitance can be prevented by proper care in filling forms, that is, by drawing off the surplus water from the concrete at the rear of the masonry.

Where surfaces had to be patched they were carefully cleaned, soaked with water and a mortar coat formed of comparatively thin layers thrown on forcibly with a trowel was applied. Each layer was permitted to harden before the application of the next. Such work has gone through three winters without signs of failure.

Iron trowels were never used in finishing the surface. By rubbing the concrete with wooden floats while it was still green, rough, sandy surfaces resembling Cleveland sandstone were secured. This excellent finish was secured at a less cost than bush-hammering if there were no surface defects to be removed.

In cases where it was desired to expose the aggregate, the mortar while green was brushed away with wire brushes. In order to obtain a good finish of this sort the aggregate must be uniform in size and placed uniformly and this is not easily done.

Very beautiful surfaces were obtained by bush-hammering a concrete made with quartz gravel.

COLORED TILE USED IN DECORATION OF PARAPETS OF THE 66TH AVE. ARCH BRIDGE, PHILADELPHIA

Colored tile were used in the decorative scheme for the 66th Ave. arch bridge over the North Pennsylvania R. R. at Philadelphia, a bridge with a 40-ft., 15° skew span 80′ wide. The arch is elliptical, built of plain concrete 2′ thick at the crown, with a minimum clearance over tracks of 16′. The spandrel walls are of the gravity type with a heavy molded coping and a solid concrete parapet or handrail, the inside of which is decorated with colored tile panels and the outside with ordinary recessed panels, as shown in Fig. 13.

The showing faces of spandrels, wing walls and outside of parapet are of a rough texture obtained by using a facing mixture of $\frac{3}{4}$-in. crusher-run stone and scrubbing the surface the day after pouring. This treatment is of the same character as that used on the other Philadelphia bridges mentioned herein. In addition to this, the spandrels and wings have the flat surface relieved by horizontal coursing joints of a V-shape.

The departure from the general practice for surface treatment of Philadelphia bridges is in the use of dull glazed, Grueby tile of different colors, in the street side of the parapet walls. The bridge, being in a fine residence district, demanded an appropriate architectural treatment, and ornamental tile panels were therefore decided upon as suitable for the portions of the bridge showing from the roadway.

From Fig. 13 it will be seen that the tile panels are set flush with the concrete backing and that the use of various sized and shaped pieces aided materially in obtaining the desired results The predominating color of the tile used is a terra cotta red, with enough dark green and blue intermingled to emphasize and give character to the design.

The parapets were poured in the late fall of 1913 and boxes were set in forms to produce recesses in the concrete 3″ deep to receive the tile and these boxes were left in place until the next spring, when they were removed and the tile set. Rods of $\frac{1}{4}$″ diam. were embedded in the concrete so as to project into the recesses and were laced together in various directions with wire before putting in the cement mortar backing for tile. The backing, with a thickness of 2″, was thus securely anchored to parapet and by placing the tile immediately the whole panel was made an integral part of the structure. The tile work was finished by pointing with neat cement and scrubbing with weak acid to remove cement stains, then washed to remove acid and coated with linseed oil.

Tile inserts have been used in other bridges as herein mentioned but they have not been entirely successful because the tile panel was not of the same size or shape as the recess left in the concrete to receive it and also because the tile panels were not made so nearly integral with the concrete as was done in this case. With the proper precautions exercised there is no doubt that this method of treatment can be made very satis-

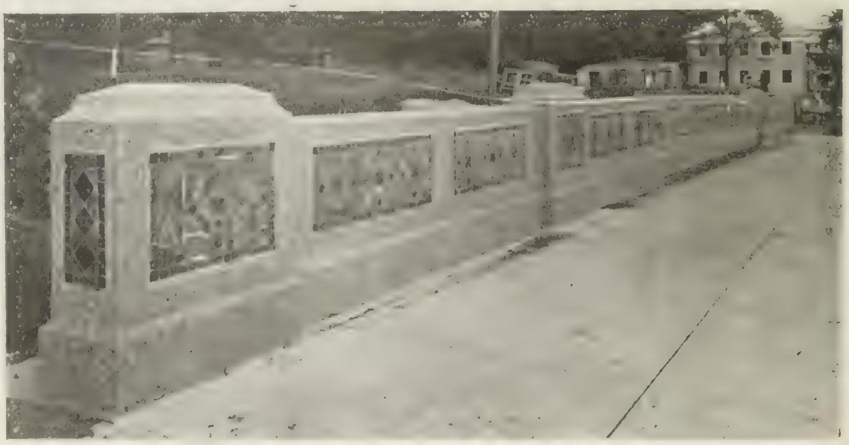

FIG. 13—66TH AVE. ARCH BRIDGE AT PHILADELPHIA

Colored tile used in decoration of parapets factory and by selecting the proper motif for the case in hand the beauty of a structure can be greatly enhanced.

CONCLUSIONS

From the preceding it can be readily seen that rubbing, brushing while still green, and bush-hammering are the most popular methods of treating concrete surfaces. The use of horizontal coursing grooves to break up the monotony of the plain concrete surface is quite often resorted to in connection with any one or all of the above mentioned methods of surface finish. The cost of these three methods of treating surfaces is about the same, varying, in general, from about 1½ cts. to 4 cts. per sq. ft., depending, of course, upon the character of the surface to be finished; the cost of bush-hammering will in many cases run much higher than the price named—sometimes exceeding 10 cts. per sq. ft. If the surface is plain and free from elaborate ornamentation, moldings, etc., the cost will be very close to the lower figure and if elaborate and cut up by panels, etc., the cost of 4 cts. will be exceeded. In so far as cost is concerned there is little or no basis or ground for the selection of any one type of surface treatment. The selection should therefore be made after a careful study as to the finish best suited to the design in hand and the surroundings.

A combination of brushed and rubbed surfaces, or rubbed and bush-hammered surfaces, often works out to very good advantage, the contrast between the finishes being very noticeable and pleasing as shown by the illustrations presented herewith. For small structures the rubbed surface is perhaps the most harmonious and effective, the surface being smooth, of fine texture and otherwise of an inconspicuous character. A brushed surface, exposing a colored aggregate, is also suitable for small work and allows a wide range of treatment.

On large structures where considerable contrast between various parts is necessary to produce the proper architectural effect, the use of bush-hammered and rubbed surfaces is to be especially recommended. For large bridges, generally viewed only at some distance away, the beauty of the brushed surface is lost and therefore it should not be used. The question of texture in this case is not paramount; the main desire is *contrast*.

By breaking up a concrete surface into small panels or courses by horizontal coursing joints the prominence of the form marks is relieved and very little further treatment is ordinarily necessary if the formwork has presented a fairly good inner surface. A small amount of rubbing will in general be all that is necessary to render a pleasing finish.

ACKNOWLEDGMENT

The writer is indebted to the following for photographs and data regarding structures in the order described: J. R. Savage(Chf. Engr., Long Island R. R.; A. B. Cohen, Concrete Engr., D. L. & W. R. R.; J. I. Higgins, Arch. and Engr., Fall River, Mass.; E. Chamberlain, Asst. Engr., P. & R. Ry. Co.; L. G. Curtis, District Engr., B. &. O., C. T. R. R.; Henry H. Quimby, Engr. of Bridges, Philadelphia; and A. J. Himes, Engr. of Grade Elimination, C. S. L. Ry.; Jonathan Jones, asst. engr., Philadelphia.

Action of Reinforced Concrete in Fire

Leonard C. Wason, Pres. of the Aberthaw Construction Co., Boston, makes a careful report of observations on the Edison fire, in the course of which he says:

> It is to be remembered that concrete poured in large sections, after setting and during the hardening process of several months, shrinks, producing internal stresses. It is impossible to anneal the material, or to do anything to relieve these stresses in the material. The steel bars embedded in the concrete cross many of these lines of stress, and tend to hold the whole mass from cracking. If a heavy blow is struck or if heat expansion takes place, cracks are likely to occur at the points of worst stress. Because of this, designers and insurance companies have insisted that no less care should be expended on sprinkler protection, cut-off walls and all other means of minimizing the extent and intensity of a fire in a reinforced concrete building than has been given to buildings of other types. The wisdom of this course is clearly shown in the fire under consideration, where these principles were not followed.

Frederick W. Taylor, Dead

Frederick Winslow Taylor died of pneumonia at Philadelphia, Mar. 21, 1915. He was best known in the field of concrete as author, with Sanford E. Thompson, of Taylor and Thompson's *Concrete—Plain and Reinforced* and also *Concrete Costs.* The latter work is an application to the concrete field of Mr. Taylor's principles of scientific management. His efficiency investigations into the operations of industrial plants and in field operations have developed remarkably the correctness and workability of his systems for economy. Mr. Taylor was 59 years old. He was at one time president of the American Society of Mechanical Engineers.

Progress in China

One of the signs of progress in China since she has established a brand-new government is the development of scientific research into concrete, its uses and elements. The Engrg. Soc. of China, through its report of a special Committee on Reinforced Concrete, has made a number of tests of the various local materials in that country and has made many of its experiments public.

The provisions of a suitable testing plant was a matter of great difficulty, and the purchase by the Municipal Council of Shanghai of a compression testing machine was helpful, as permission was obtained to use this. The Municipal Council also assisted financially by making a grant to the Society, and without this timely help from the Council practically nothing could have been carried out.

Three brands of cement, all of which are Chinese, were tested, and these were found to comply with the British standard specification in each case. Six kinds of local sand were tested, together with six varieties of local stone, and, generally speaking, these were all found satisfactory, with the exception of the Soochow sands, which were shown to be inferior and not to be recommended.

The reinforcement tested consisted of ordinary round and deformed bars, and these tests were conducted, by the permission of the Chinese authorities, at the Shanghai Arsenal, the machine used being a single-lever machine (Wickstead's Patent) manufactured by Buckton and Co., Leeds, and capable of exerting a pull of 50 tons and testing material having a breaking strength of 300 tons per sq. in.

There is no definite rule as to the length of time that arch centering should remain in place; the time, however, should not be less than two wks. for spans up to 45′ if the arch is back-filled at once; when the centering is not to be used again it is better to let it stand considerably longer. Arches of small spans up to 15′ may have the centering removed in about a week's time. For very large arches the problem of removing the centering becomes a special one and should receive the special attention of the engineer.

Broken stone should be nearly cubical in form, as thin, flat particles will not pack well. The shape of the fragments has an important effect on the proportion of voids in the mass.

FIG. 1 THE CANAL ZONE ADMINISTRATION BUILDING AT BALBOA, SHOWING TERMINALS AND TOWNSITE AND MIRAFLORES LOCKS IN THE DISTANCE

The Manufacture of Hollow Concrete Block in the Canal Zone—The Administration Building

The accompanying notes on the manufacture and use of concrete structural tile or block by the U. S. government in the Canal Zone are prepared from descriptions published in The Canal Record, *supplemented by data supplied direct to this magazine through Gov. Goethals, by Frank Holmes, resident engineer, who also sent the photographs for the accompanying illustrations.*

Concrete structural tile or block are being manufactured and used extensively by the U. S. government in the Canal Zone in the construction of permanent buildings, chief among which thus far is the new administration building at Balboa.

The plant in which the units are manufactured is at Corozal. The process is the invention of A. A. Pauly.[1] It employs a very wet mixture and quick release from the molds is made possible by the application of steam within the molding apparatus. The machines being used by the U. S. government have numerous improvements over the original machines made and used in this country. In 9 mos. of operation from Nov., 1913, to Aug., 1914, a total of 902,308 tile or block of various sizes, from 3″x12″x12″ to 12″x12″x18″, were made.

The exclusive right of manufacture on the Isthmus was acquired by the Canal Commission, and Mr. Pauly personally supervised the installation of the molding machinery.

Concrete for the block is mixed in the following proportions: 2½ parts cement, 3 parts Punta Chamé sand, and 6 parts stone screenings passing ½-in. mesh from the Ancon quarry. The materials are hoisted by an elevator to a platform at the top of the building and dumped into a ½-cu. yd. Smith[2] mixer (see Fig. ..). This mixer discharges by means of a 2-way chute into two wooden troughs, each served by an agitator, consisting of an iron rod to which is attached a series of blades. The agitators move forward and backward horizontally, the passing of the blades through the mixture serving to keep it constantly stirred up. The object of the agitators is to prevent the concrete from stiffening and to give it the proper age. The agitator troughs are provided with valves, one to each of the 12 molding machines. These machines are arranged in two rows, six machines on each side of the agitator troughs, and are capable of producing block of the following sizes: 12″ x 12″ x 18″ for founda-

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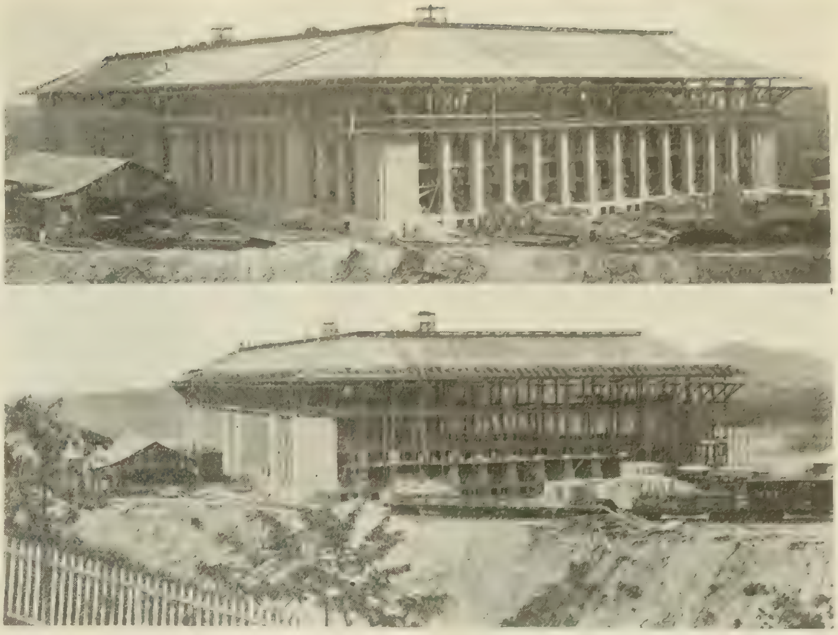
Youngstown, Ohio

tions, or walls; 8″ x 12″ x 12″ for main walls; 8″ x 8″ x 16″ for corners; 6″ x 12″ x 12″ and 4″ x 12″ x 12″ for partitions, and 3″ x 12″ x 12″ for interior columns.

Each molding machine is of cast steel construction and raised a short distance, thus placing the top of the machine 5′ 5″ above the floor, and each machine is capable of turning out four block at a single operation, except the 12″ x 12″ x 18″ machines, which turn out three block per operation. The forms are enclosed within a double cast steel lining, with a space between for the admission of steam. In molding a block, the first step is to insert a cast iron frame, or pallet, having the shape of the solid portion of the required block, at the bottom of the mold; this serves as a base and support for the tile. The valve in the agitator trough is then opened, and the concrete is allowed to flow down a short chute to the top of the mold. The workman in charge of the machine, using a trowel, then diverts the thin or wet concrete into the crevices around the forms until all are filed level with the top. Steam, which may be graduated to the desired pressure by a series of valves located beneath the machine, is then turned on for a period of 4 min. The steam causes the mixture to heat until a sufficient amount of moisture is evaporated and the thin concrete stiffened so that it will stand alone, when it is turned out of the mold by means of a crank, which pushes the pallet, and the tile which rests upon it, upward until they are in the clear above the top of the machine. Careful handling at this stage is necessary, the block being lifted from the mold and transferred to short lengths of wooden planking placed on receiving racks, or elevators, by means of a wooden device which clamps the sides of the block closely and also fits beneath the pallet. There are six of these receiving racks or elevators, so constructed that when the first plank or shelf is loaded with tile, the turning of a crank lowers the shelf about 20″ and another plank is placed, for loading, on the angle iron brackets which automatically appear at the top of the rack; this result is obtained by spacing brackets, at equal distances of 19⅝″, along four endless chains which pass over sprockets actuated by crank. Each elevator has a capacity of four loaded shelves. The elevators are set with the top shelf on a level with the top of the tile-making machinery, and each elevator serves two machines. The block are removed from the elevator to the curing rooms, or alleys, by a special truck provided with arms, which, when extended under the elevator shelves, and raised by means of a lever on the truck, remove the planks and their loads from the elevator, the planks resting securely on the arms of the truck (see Fig. 6).


Figs. 2 and 3—Administration Building Under Construction, Showing Use of Concrete Block

The curing rooms consist of 24 galvanized iron compartments, each about 45′ long, 4′ wide and 8′ high, entirely enclosed, and equipped with racks in tiers. Twelve of these compartments are situated on one side of the plant, and 12 on the other. In these rooms, the block are given their perfecting treatment, which consists of a combined steam and water-dripping process, calculated to facilitate the setting up and hardening of the concrete, so that within a period of 24 hrs. to 48 hrs., the block are ready to be removed to the storage yard. Block are then sprinkled for 10 das.

Each mold is attended by one man, with a helper for each two machines. Double shifts of 8 hrs. have been necessary.

The storage yard consists of a large space adjacent to the plant on the west, which has been leveled off, with trucking ways concreted through

Fig. 4—Not a Clear Picture—Yet Showing Layout of Troughs, Agitators and Machines in the Plant for Making Hollow Block, or Tile

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[2] T. L. Smith Co., Milwaukee

it. A railroad track for loading the block on cars extends along the outer side of the yard.

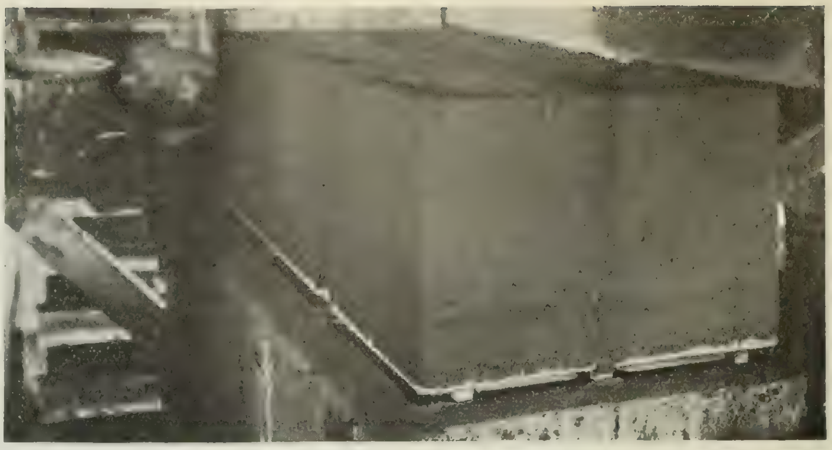

Fig. 5—Detail View of Hollow Block Just as Forced Upwards on Pallet Out of Steam-Heated Steel Jacket

Each unit of the machinery is operated by individual electric motors, the power being furnished from the Miraflores station. Steam is generated by two boilers located in a shed outside the plant. One of these boilers was taken from the old carpenter shop at Gorgona, and the other from the stock in disuse at Mount Hope.

Now that the greater portion of the erection of the new building authorized has been accomplished, the demand for the larger units, used principally in exterior walls, has dropped off, and the principal present demands is for 3-in., 4-in. and 6-in. block (all 12″ wide by 12″ long), for use in interior columns and partitions.

Work on the smaller block is being carried on to the capacity of the machines equipped with molds of these sizes. The output of the Pauly machines originally installed in the plant has been supplemented by the use of four hand-operated machines for smaller units made by the dry process, and these machines were constructed for field use when the building operations were in full swing.

During the height of construction of the new Administration building, the permanent quarters, and the electric substations, the output from the Corozal plant was not sufficient to meet the demand, and additional equipment for making similar hollow concrete block by the dry process was installed on the townsite at Balboa in the form of eight portable molding machines. Two of these machines made block 3″ x 12″ x 14″; two made block 3″ x 12″ x 12″, and four made block 4″ x 12″ x 12″. The block made by the two machines first mentioned were for the columns in the new Administration building; this size is not beiing used now. This field plant produced a total of 30,000 block.

The field machines have since been transferred to Corozal to be operated in connection with the Pauly process plant. They are wooden structures, devised by concrete foreman and carpenters at Balboa, and each occupies a space about 6′ long, 4′ high, and 4′ deep. Each contains a trough, with removable ends and partitions, in which are set the molds for four block, each 3″ x 12″ x 12″. The moistened concrete material is deposited into the molds from above by hand, and tamped by means of a mallet and a steel bar. Each machine is operated by two laborers, the material being mixed by another in an adjacent trough. The output is about 150 block per machine in each 8-hr. shift. Materials are used in the same proportions as for the wet process. The blocks turned out have been generally satisfactory, though showing less uniformity and greater breakage than those manufactured by the wet process.

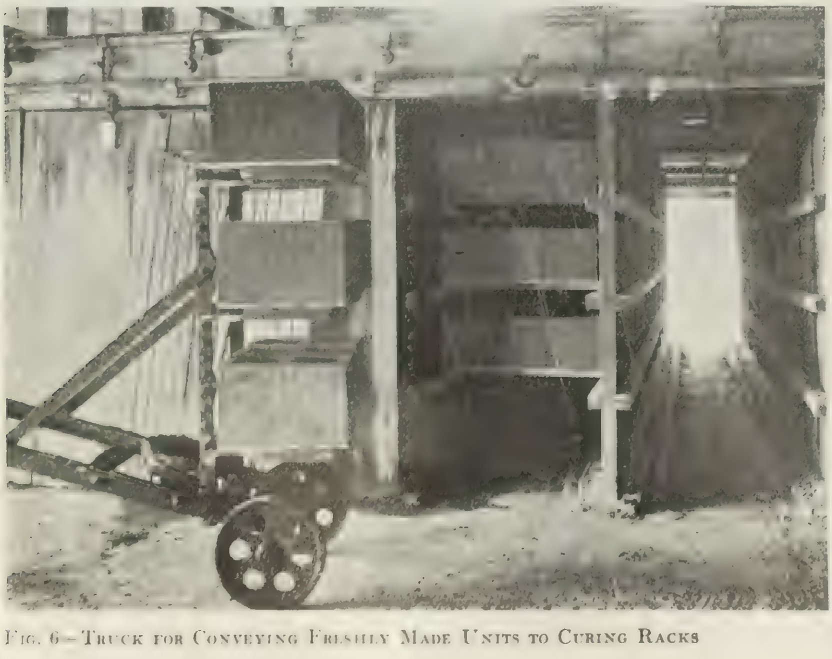

Fig. 6—Truck for Conveying Freshly Made Units to Curing Racks

Since the first units were turned out several improvements have been made in the methods of operating at the plant, which have made it possible to reduce the force of laborers by about one-half. One is the substitution of a power-driven tumbler or rattler for hand labor in removing particles of concrete from the cast iron pallets, which, inserted at the bottoms of the molds, form the bases on which the block are handled until they harden, when the pallets are loosened by a hammer. Two laborers operate the tumbler and do work for which 14 men were formerly required.

Another device which has given general satisfaction is a washer for cleaning screenings. The screenings are shoveled from the cars into an inclined trough, about 10′ long, at both ends of which are powerful jets which throw the screenings into motion. As they slide down the flume they fall on inclined screens, the particles of rock passing through into a pile, while the finer particles of earth are carried away by the water, through a discharge flume. In addition to cleansing the screenings mechanically, and allowing a reduction of force of 12 laborers, the washer has done away with dust, which was formerly very objectionable. Moreover, as the finer particles are carried away and settle, a quantity of sand can be skimmed off the top. This is used to a great extent in place of Chamé sand and effects considerable saving in the cost of material.

Block are now shipped to the permanent quarters at Balboa, the office building for Balboa shops, and the substations at Cristobal and Balboa. The substations are still using all sizes, but at the other points the consumption is almost entirely confined to the smaller sizes. The distribution of the block manufactured at the Corozal plant up to Aug. 10, 1914, is shown in the accompanying table.

Destination	3″x12″x12″	4″x12″x12″	6″x12″x12″	8″x12″x12″	8″x12″x16″	12″x12″x18″	Total
Permanent quarters..	29,233	79,722	52,566	98,520	63,873	17,441	341,355
Administration Bldg...	36,316	39,900	22,867	53,863	15,731	18,621	187,118
Miraflores substation..	8,443	18,016	6,006	16,020	......	10,105	58,590
Gatun substation ...	8,088	12,516	4,253	12,989	1,032	10,381	49,259
Shops office bldg.....	6,825	14,224	4,779	8,395	6,256	3,108	43,587
Cristobal substation ..	9,869	11,729	8,539	8,404	1,099	7,432	47,072
Balboa substation ...	4,291	10,851	2,756	11,768	2,190	5,526	37,382
Total shipped	103,065	186,958	101,766	209,799	90,181	72,614	764,363
In storage	6,226	4,958	2,311	80,707	32,148	11,595	137,945
Grand total	109,291	191,916	104,077	290,486	122,329	84,209	902,308

ADMINISTRATION BUILDING

The Administration building, the most important structure in which the concrete units have been used, is on the northwestern slope of Ancon Hill, overlooking Balboa, the first permanent town of the Zone. The building is in plan in the form of a letter E, 325′ on the front and each of the two main wings 182′ long.

The design of the exterior of the building adapts the Renaissance of the 15th century in Italy to modern building conditions and materials and to local requirements.

The front and the outer sides of the wings are characterized by a basement story about 5′ above the ground, and a two-story colonnade of square columns, supporting the third story wall and the eaves of the roof.

In the large wall area over the front entrance, at the third story level, a decorative inscription, flanked by two cartouches, has been placed. The letters are sunk in a V section and are 10″ high; the cartouches bear the letters U. S. and C. Z. in monogram.

CONCRETE ON THE TERRACES

The building is surrounded on all sides by wide concrete paved terraces, set off at the front by panels of lawn running longitudinally, and bounded by concrete balustrades at the outer edge. The center of the court side is taken up by a large circular panel of lawn sloping easily away from the building, around which roads lead up to the porte cochere, and to the wagon doors of the Paymaster's and Collector's offices in the wings. The latter roads are 4′ above the main court level at the ends of the wings, making necessary a low retaining wall, which is crowned by a balustrade. On the center line of the ends of the wings a short flight of steps leads from this upper level down to the main court; concrete sidewalks connect all the entrances of the building with the main highways and with the steps leading down to the railroad station.

The paved terrace at the front of the building is 50′ wide to the center of the balustrade; the southeast side is 16′ wide, and the northwest side is 12′ wide; all are bounded by the balustrade, which is constructed of pre-cast base moldings, pedestals, balusters and cap moldings, all reinforced and cast in plaster molds. They were set up, hooked together with steel and grouted in, after which all joints and defects were pointed up. The balusters are 4½″ x 4½″, with plain small caps and bases; there will be approximately 1,000 of them used. The same type of balustrade will also be used on the ramp retaining walls at the foot of the main front steps.

CONCRETE FLAGSTAFF

On the broad terrace of the southwest, or town front, of the Administration building, a reinforced concrete flagstaff has been constructed, on the main axis of the building and 59′ away from it. Its position at the head of the spacious flight of steps from the terrace to the main townsite gives it added prominence, and it can be seen from a considerable distance. The top of the pole is 70′ above the terrace level; the foundation extends 12′ below it and rests on natural soil. It is 16-sided, and has a diameter of 8½″ at the top and 17″ where it joins the ornamental base.

It is reinforced longitudinally by 8 square bars, which are 1½″ in diameter at the base, graduate down to ¾″ at the top and are welded together at intervals to form continuous rods from top to bottom. The welds are staggered, so that they do not all come at the same elevation. Horizontal reinforcement is obtained by the use of hoops of ⅜-in. x ⅛-in. bars spaced every 4″. The concrete was a 1:1:2 mixture, using Chamé sand and Ancon rock; and about two cu. yds. were used for that part of the pole above ground, excluding the spreading base members.

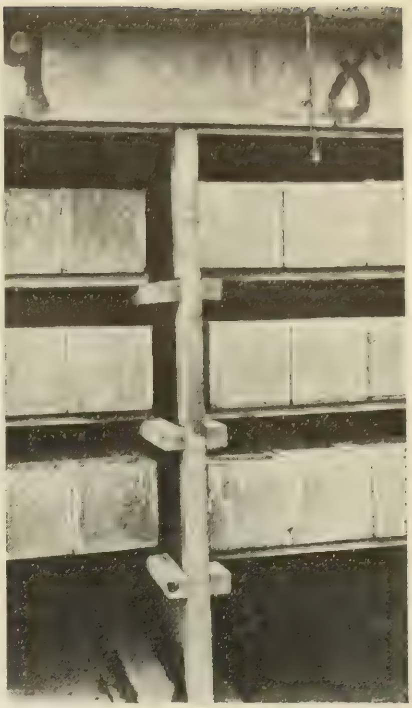

Fig. 7—Curing Rooms

The pole was cast horizontally on the ground in wood forms, which had to be constantly adjusted to keep the pole in alignment, due to the settling of the fill on which the forms were set up, and to blasting in the neighborhood. Eighteen das. after pouring, it was erected; stresses were developed during the erection much greater than would be caused by a hurricane of 100 mi. per hr. velocity.

The lower 10′ of the pole consists

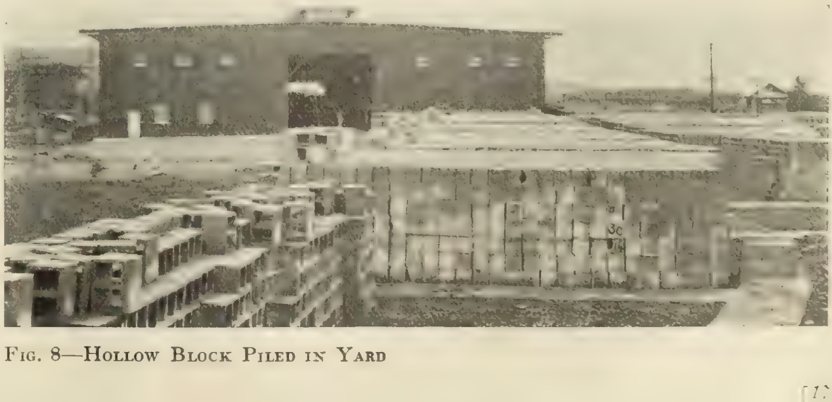

Fig. 8—Hollow Block Piled in Yard

of a spreading octagonal base of flutes and plain moldings, with a seat and a platform at the bottom. These members were all pre-cast and set up after the pole was erected. They are about 3″ thick and heavily reinforced with mesh. The pole itself received a thin coat of stucco after erection to true up the arrises and to remove all form marks.

THE MAIN OUTSIDE STAIRS

On the center line of the building, starting at the flagstaff, a broad concrete stair leads from the main terrace to the Prado below, where it gives onto the plaza at the foot of hill. It is 40′ wide at the main portion, dividing into two smaller parts where it meets the semicircular base of the flagstaff; at the bottom inclined ramps, normal to the main stair, carry the traffic off to either side of the plaza. A retaining wall, crowned by a balustrade, carries the two ramps from the lowest platform of the main stair down to the plaza level.

The stair has four flights and two ramps. The semicircular flights at the top are 20′ wide and have 18 steps each, while the three main flights have 30 steps each, and are 40′ wide. The proportion of rise to tread is 6″ to 13½″, each tread having a wash of ¼″.

Each platform is drained by a concrete gutter, under a concrete grille, through the cheek wall, 21′ 6″ wide, on either side of the steps to the earth terraces on either side.

Foundations are of 1:3:5 concrete, without reinforcement, and the superstructure is of steel skeleton. Floor arches are of 1:2:4 concrete reinforced with Clinton wire cloth.[3] All stairways are of reinforced concrete, as are belt courses and soffit of roof overhang. Sills are of concrete cast in wood molds with rubbed finish. Caps and bases with more elaborate detail were cast in plaster molds and also given a rubbed finish. The finish was obtained by the use of concrete brick composed of 1 part cement and 2 parts sand. This finish cost about 4 cts. per sq. ft., using colored labor at 13 cts. per hr. This included cost of scaffolding. Curtain walls and partitions are of hollow concrete block.

The roof slab is composed of sawdust concrete, 1 part cement, 4 parts sand and 1 part sawdust. The material was mixed as a moist mixture in a Ransome[4] mixer, and placed in the same manner as ordinary stone or cinder concrete would be placed in a slab. The slab, which was 4″ in thickness, was reinforced with Clinton wire cloth and had spans approximately 6′ in length. The only advantage obtained by the use of sawdust concrete was that it permitted the roofing tile and felt to be nailed directly to the slab. This is covered with 30-lb. asphalt felt and dark red Spanish tile.

The exterior porches and corridors are floored with Adamantine red tile, 6″ x 6″, set in Dykerhoff cement with a sanitary base of the same material. The rotunda and the main stair halls on all floors are floored with white Italian marble mosaic, with pink Tennessee marble, hone finish, borders. Stair treads and risers are of the same material. The columns in the rotunda, first floor, are of polished Pavanozzo marble, each column being a monolith.

The walls of the rotunda and the main stair hall on all floors are finished in white cement plaster, 1 part white Medusa[5] cement, 2 parts sand, and ½ part Keene's cement, troweled to a float finish, above a verde antique marble base and stair strings.

All of the ceilings throughout the building and the walls of the office portion, including the corridors above the 5-ft. wainscot, are finished in white plaster. The wainscot of the corridors has the same finish as the walls of the rotunda and main stair hall but finishes upon a Dykerhoff cement base. The walls of the Board room, third floor, from the cornice to the chair rail, are finished in Keene's cement. Below the stair rail the finish is the same as that of the rotunda walls; base, chair rail and picture mold are of solid mahogany.

All of the office floors are of yellow pine, comb-grained, 2½″ wide, laid on 3-in. x 3-in. redwood sleepers. 16″ o. c., embedded in cinder concrete, 1:3:6 mixture, with a layer of Neponset paper[6] between the floor and the fill. The cost per sq. ft. above the concrete slab was 20 cts.

The walls of the toilet rooms are finished with 3″ x 6″ white glazed tile 6′ 6″ above the floor, with white plaster above. Partitions, stiles, etc., are of polished pink Tennessee marble, and floor of 2-in. hexagonal white vitrified tile.

The floor of the basement is 1:3:5 concrete with Portland cement, steel trowel finish. The walls are plastered with Portland cement plaster. The ceiling is finished by rubbing the under side of the first floor arch with a concrete brick. All of the exterior walls are stuccoed with a wood float finish, stucco composed of 1 part Portland cement, 2 parts sand, and ¼ part of limoid,[7] this with the exception of the belt courses and the overhang previously mentioned.

Concrete Standard for a Bird House—Residence of O. C. Barber, Barberton, Ohio

Layers of concrete should not be tapered off, but be built with square ends and when, from any cause, it becomes impractical to complete a layer, a plank of convenient width should be secured to the form, against which the concrete should be rammed, thus making a vertical joint.

Under the title of the "Dawn of a New Age," one of the leading American cement companies pays a tribute in its advertising matter to the wonderful progress concrete is making. It shows an enormous stone handling plant of the most modern form of construction, all built of concrete and it well closes its summary of the "dawn of this cement age" by saying "It is a significant fact that even in the stone handling structures of to-day stone for convenience, economy and greater strength is being replaced by concrete."

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[3] Clinton Wire Cloth Co., Clinton, Mass.

[4] Ransome Concrete Machy. Co., Dunellen, N. J.

[5] Sandusky Portland Cement Co., Sandusky, Ohio

[6] Bird & Son, East Walpole, Mass.

[7] Hydrated Lime, Charles Warner Co., Wilmington, Del.

Building Code Regulation of Concrete Block and Other Building Units

By Harvey Whipple

The purpose of this discussion is to bring before manufacturers of concrete block, trim stone and of all building units of factory-made stone, the matter of building regulations affecting their products. The discussion is general and most of the suggestions are tentative. It is an open subject, of great importance. It affects the business of every man who makes a concrete block or a piece of trim stone for building purposes. Every such manufacturer is invited to present his views—backed up so far as possible by data as to strength, absorptiveness and other qualities of his own products—(the regular commercial output) and of competing products, such as clay brick and natural stone, in his locality. Any information will be welcome which throws any light on present building regulations, on market prices or on the general character of concrete products in every community.

Attention is called to discussions in the Information and Consultation Department this month along the same line as the following article. The question on which these discussions are based is from Detroit, where efforts are being made to amend the building code in its regulation of concrete block.

This is a live subject. Let everybody help in threshing it out.

The data thus brought together should help manufacturers to cope with their local building code matters as they develop.

In general there are two causes for complaint by manufacturers of concrete building units with regard to building regulations affecting their products.

One complaint is that regulations are too exacting; are unfair as compared with the regulations of competing materials or too restricting in the sense that concrete units are not recognized at their full value.

The other complaint is that regulations are inadequate or that there are no regulations at all, with the result in either case that concrete building units are being discredited through the unrestricted operations of unscrupulous or ignorant manufacturers.

Both causes of dissatisfaction are sources of much annoyance and discouragement. Yet the situation most in need of prompt remedy is in the case of no regulations at all or of inadequate regulations, either condition of affairs being more likely to do serious harm to the industry of concrete building unit manufacture than is the inconvenience of too much regulation. It is remarkable, however, in this connection that there are very few complaints from manufacturers who are operating under no building code regulations, while there are numerous complaints from manufacturers who feel that they are the victims of too much regulation. This is true in spite of—or perhaps because of—the fact that the cities and towns which have any ordinances regulating concrete building unit manufacture and use are few as compared with those which have not adopted such measures for public protection. It is human to go in the way of least resistance and then when some measure of resistance does present itself, to exaggerate the strength or importance of the opposition. The further a man goes without meeting resistance, the less cheerful is the ultimate encounter.

Some manufacturers will do their level best to make good concrete building units even when they are not actuated by the necessity of meeting building code requirements. These manufacturers should be very anxious to see their industry placed under regulations which will maintain high standards. It is only in this way that the conscientious manufacturer is released from a galling competition with the man who has been taking advantage of building code laxity to make the cheapest and poorest product. Such competition is deadly in its effect on an industry. It not only puts the conscientious manufacturer under a strong temptation to go the limit in the same direction, but it forces him, whether he does or does not yield to the temptation, to suffer the evil consequences of the use of poor products in his community—whether his competitor's or his own. He not only suffers the immediate effect of the price competition in the sacrifice of legitimate profits or deterioration of product, but eventually he reaps his share of the harvest of public displeasure when the poor products used in his community begin to develop their weaknesses. He may have kept up the quality of his own products, and still suffer from the reaction which follows the use of his competitor's poor products. While in the end, providing he can hold out long enough, the man who makes the good product is bound to win and get the community's business, still it takes the public a long time to learn to distinguish the good from the bad and it requires the cumulative influence of many good jobs to offset the effect of one failure.

Building regulations are of no less advantage to the manufacturers of the products regulated than to the public which uses the products. The public should adopt regulations to protect itself against inferior materials which it has not the special knowledge to recognize and avoid. The public may like the looks of a unit and yet have no idea of the qualities it should have. When such regulations are adopted manufacturers are benefited by being put on an even basis for competition. The manufacturer who is paying the price for carefully selected materials, who is using equipment and maintaining an organization to use those materials scientifically in the production of sound and attractive building units, will not be handicapped by the methods of competitors who are less thorough, perhaps less conscientious, and who can produce inferior units at a very low price.

It is certainly desirable that concrete building units be standardized and that the standard shall be much higher than the present average. If architects, builders and the public generally are indifferent to the matter of desired regulations, the manufacturers should take the initiative, with the necessary steps to have suitable regulations adopted.

In determining the various requirements several things are to be considered, and the following are offered as suggestions:

(1) The standard should be within commercial possibilities. That is, the limitations of present mechanical development in molding equipment should determine the standard. It is possible to make concrete stone to test at 4,000 lbs. per sq. in. in compression, but it is not commercially feasible when the unit is to be used to compete with anything but high-priced building units. It is possible to make concrete stone with absorption as low as 3%, or lower, and yet this does not appear to be a thing of

commercial feasibility except when the price is to be high.

(2) The standard should be with some consideration of acceptable standards in competing materials. Here, the manufacturer is likely to make a grave mistake, however, if he endeavors to keep the standard for his material *down* to the standards of the poorest competing materials. There is no excuse for a manufacturer who is not making concrete building units to test better than much of the common clay brick on the market. Concrete units are a commercial possibility with higher strength and lower absorption than most common brick—selling at a lower price with better quality. In a community in which common clay brick will show absorption up to 15% and 20%, it is unjust to demand concrete block which will show absorption of 5% only. It is also unjust (to the progressive concrete products manufacturer) to permit the use of concrete block having an absorption of 20%. Concrete block should probably be allowed at between 7% and 10% absorption (face immersed ½″ for 48 hrs. in water, face of block being supported above bottom of vessel) and at a crushing value of 1,500 lbs. per sq. in. of net bearing section of block. This means about 1,000 lbs. gross section with most block on the market.

[As a note in connection with these standards of quality, manufacturers should have their products tested, fairly and impartially. It is folly to try to fool the public long; it is vastly greater folly to try to fool one's self. Then there should be further investigation of what relation exists between absorption and crushing strength. Such investigations might indicate different suggestions as to strength and absorption values.]

(3) There appears so far no recognition of concrete of very high quality such as is being specified by some architects in important building construction in place of high quality limestone and occasionally instead of marble and granite. Nor is there any recognition of concrete stone of special architectural value. Either the many possibilities of factory-made concrete stone must be recognized in a building code, with a sliding scale of requirements, or else the higher qualities must be left to the individual architect to specify for each job according to his idea of the requirements and his knowledge of what degree of quality is possible by particular manufacturers whose products he desires to use.

The accompanying tabulated data[1] as to building regulations in various cities give an idea of how far from standard the existing regulations are.

Building Code Regulations of Concrete Block in 27 Cities

City	Date of Ordinance	Height Limitations S=Stories F=Feet	Hollow space shall not exceed—%	Crushing Strength 28 das.—lbs. per sq. in. Gross or Net Area	% of Absorption	Age of block in das. when used
Albany, N. Y.	'09	6S	33[2]	1,000G	..	21
Baltimore, Md.	'08	6S	45[2]	1,500	7[4]	28
Birmingham, Ala.	'12	3S	25	1,000	15[4]	21
Buffalo, N. Y.	...	3S	33⅓	.....	..	..
Chicago, Ill.	'14	2S[1]	..	.....	..	..
Cincinnati, Ohio	'13	note[1]	..	.....	..	..
Cleveland, Ohio	'11	3S	35	1,500	7[4]	28
Detroit, Mich.	'11	4S	note[2]	1,500N	5[4]	28
Elizabeth, N. J.	'08	6S	33[2]	1,000G	..	..
Hoboken, N. J.	'11	2S	33⅓	1,000G	..	..
Indianapolis, Ind.	...	2S	33⅓	800G[3]	..	20
Jersey City, N. J.	'07	..	33	1,000G	..	..
Los Angeles, Cal.	'14	2S[1]	..	.....	..	..
Manchester, N. H.	'11	3S	33⅓	1,500N	..	28
Memphis, Tenn.	'14	..	..	1,500[3]	16[4]	21
Milwaukee, Wis.	'14	60F	35	700	..	..
Newark, N. J.	'11	3S	33	1,000G	..	21
New Haven, Conn.	'12	6S	..	1,000G	..	21
New York, N. Y.	'13	3S[1]	33⅓	1,500N	..	28
Philadelphia, Pa.	'13	6S	33[2]	1,000G[3]	15[4]	28
Portland, Ore.	'13	3S	note[2]	note[3]	7	28
Rochester, N. Y.	'11	3S[1]	33⅓	450G	..	15[5]
Springfield, Mass.	'12	3S[2]	33	1,500[3]	..	..
St. Paul, Minn.	'10	3S	..	1,000G	..	21
Syracuse, N. Y.	'13	3S	33	1,000G	..	28
Waterbury, Conn.	'10	35F	33⅓	1,500N	..	..
Worcester, Mass.	'11	4S	33	.....	..	21

Notes Completing Above Table

[1] *Height*—Chicago, permissible for residences, garages, stables and apartments. Cincinnati, used where brick are permissible. Los Angeles, hollow block not permitted for exposed walls in certain districts; other districts limited to two stories. "Artificial Stone, made of Portland cement and incombustible and fireproof and waterproof, may be used as substitute for natural stone, providing no bearing members in buildings over three stories contain more than 15% of lime or limestone." New York, height also limited to 36′. Rochester, height also limited to 43′. Springfield, height also limited to 40′.

[2] *Hollow Space*—Albany, 33%, 1-story and 2-story walls; 1st story, 25% for 3-story and 4-story walls; 1st story, 20% and 2nd story and 3rd story, 25% for 5-story and 6-story walls. Baltimore, 45% for 1-story and 2-story; 1st story, 35% for 3-story and 4-story walls; 1st story, 25% and 2nd story 35% for 5-story and 6-story walls. Detroit, same as Baltimore for 1, 2, 3 and 4 stories. Elizabeth, hollow space limited to 25% for 3 lower stories of 5-story and 6-story walls. Philadelphia, 33% for 1-story and 2-story; 1st story, 25% for 3-story and 4-20% and 2nd story and 3rd story, 25% for 5-story and 6-story buildings. Portland, Ore., 45% in 1-story and 2-story walls; 1st story, 35% in 3-story walls.

[3] *Crushing Strength, 28 das., lbs. per sq. in.*—Indianapolis, strength at 30 das. instead of 28 das. Memphis, strength of 1,500 lbs. required at 8 das. Philadelphia, average strength 1,000 lbs, gross area, no block to fall below 700 lbs. Portland, Ore., 1,500 lbs. average, in no case below 700 lbs. Springfield, Mass., 1,500 lbs. at 30 das.

[4] *Percent of Absorption*—Baltimore, average 7, maximum 10. Birmingham, average 15, maximum 18. Cleveland, average 7, maximum 10, block immersed ½″ face down 48 hrs. Detroit, average 5, maximum 7, total immersion 48 hrs. (The most unreasonably severe restriction found in 27 cities.) Memphis, average 16, maximum 22. Philadelphia, average 15, maximum 20, ½″ immersion face down 48 hrs.

[5] Block may be used in 5 das. if cured by steam.

Marks of Identification—The marking of block to identify manufacturer is required in Birmingham, Detroit, Hoboken, Manchester, Memphis, Milwaukee, Newark, New York, Portland, Springfield, Syracuse and Worcester. Block are required to be marked with date of manufacture in Birmingham, Memphis and Newark, and in Birmingham the mixture used must be indicated.

Party Walls—Party walls must be solid in Albany, Birmingham, Indianapolis, Manchester, Milwaukee, New Haven, Springfield, St. Paul, Syracuse and Worcester.

Loads—In Birmingham block may be loaded 8 tons per sq. ft.; Buffalo 150 lbs. per sq. in. of net area (not including hollow space); Cleveland, 200 lbs. per sq. in.; Los Angeles requires factor of safety of 10; New York, 100 lbs. per sq. in.; Philadelphia, 8 tons per sq. ft.; Waterbury, Conn., 100 lbs. per sq. in.

Thickness of Wall—Thickness of wall is the same as required for brick in Birmingham (upper story may be 8-in. block), Buffalo, Chicago, Cincinnati (wherever brick are permissible), Detroit, Hoboken, Indianapolis, Jersey City, Manchester, Newark, New York, Philadelphia, Portland, Springfield, St. Paul, Syracuse, Waterbury, Worcester. In Cincinnati, an 8-in. block wall may be used where 9″ of brick are required. (As a matter of fact this is the customary practice in most cities.) In Cleveland the 8-in. block wall is considered 1 brick thick. In Memphis and New Haven the block wall may be 10% less in thickness than brick walls.

Thickness of Web of Hollow Block—Jersey City, Manchester, New York, Syracuse and Waterbury require that webs and walls of each block shall equal ¼ of the height.

Walls.—All exterior or division walls of buildings erected shall be of sufficient thickness to support the load to be carried; but in no case shall a brick, stone, concrete, or hollow block wall be less than 12″ thick.

The following paragraph by the writer is from the chapter on building regulations in *Concrete Stone Manufacture.*[1]

Local building regulations, so far as they restrict the use of a given material, are, in a broad way, a reflection of the popular or at least the predominating degree of confidence in that material. This confidence is, to some extent, a product of a community's experience with the material in question, or its observation of it, or of a reflected experience from some other community which has taken the initiative in regulating the use of similar material. The natural conservatism favors established standards and tried materials, and a natural skepticism judges a material by its poorest samples, discounts its numerous successes by its fewer failures and establishes standards for defense against the worst which may be expected. In individual cases a material might suffer from discrimination due to the legislative influence of established commercial interests which would be called upon to compete with a newer product.

Looking squarely at this situation it is obviously the part of wisdom for manufacturers of concrete products to restore public confidence where it has been lost and to build up confidence where it has never been gained. It is true that many conscientious and competent manufacturers are working against odds in correcting public misconceptions and removing prejudices which have become established through the work of unscrupulous and incompetent manufacturers. This, however, does not alter the facts of the situation in the least and does not in the smallest degree affect the necessity of a rehabilitation of an industry and a re-establishment of its products by the strictest adherence to good practice in every manufacturing operation.

SUGGESTED CODE FOR SMALL MUNICIPALITIES

In addition to the tabulated data, following are the requirements for hollow concrete block from *Code of Suggested Ordinances for Small Municipalities,* adopted by the National Board of Fire Underwriters:

Limits of Height and Area.—Except as specified in Section 21, no building hereafter erected within the corporate limits, having walls of hollow terra cotta or concrete block, shall exceed three stories, or 40′ in height, and no building hereafter erected or altered shall exceed four stories or 55′ in height, unless it be of fireproof construction, when it shall not exceed 10 stories of 125′.

The floor area between fire walls of non-fireproof buildings shall not exceed the following: When fronting on one street, 5,000 sq. ft.; when fronting on two streets, 6,000 sq. ft., and when fronting on three streets, 7,500 sq. ft. These area limits may be increased under the following conditions as indicated:

For non-fireproof buildings, fully equipped with approved automatic sprinklers, 50%.

For fireproof buildings, not exceeding 125′ in height, 50%.

For fireproof buildings not exceeding 125′ in height, fully equipped with approved automatic sprinklers, 100%.

Walls, excepting party and fire walls, for all buildings of other than the dwelling house class, not exceeding five stories or 65′ in height, shall have the upper two stories not less than 12″ thick increasing 4″ in thickness for each two stories or fraction thereof below. For such buildings in excess of five stories, but not exceeding 10 stories or 125′ in height, the top story shall be not less than 12″ thick, increasing 4″ in thickness for each two stories or fraction thereof below. No two-story increment shall exceed 30′ in height.

Hollow block of terra cotta or concrete when used for bearing walls shall have not more than 50% of cellular space. Portland cement only shall be used in the manufacture of concrete block. The coarse aggregate shall be of suitable material graded in size, but in no case shall the maximum dimension exceed one-half the minimum width of any section of the finished block. Concrete block shall not be used in construction until they have attained the age of 28 das., or developed the strength required in this section. All building block shall be laid in Portland cement mortar.

The compressive strength of building block shall in all cases be calculated upon the gross area of the bedding faces, no account being taken of the cellular spaces. The average ultimate compressive strength for terra cotta block laid with cells vertical shall be not less than 1,200 lbs. per sq. in.; the average for concrete block laid with cells vertical shall be not less than 800 lbs. per sq. in. Concrete block shall be not more than 36 das. old when tested. The average strength of the block as here given shall be obtained by testing 10 block of average quality.

The allowable working stress of hollow building block shall not exceed 100 lbs. per sq. in. of gross area for terra cotta block, or 75 lbs. per sq. in. of gross area for concrete block. If a wall be built of block with the cells horizontal, the allowable working stress shall not exceed 30 lbs. per sq. in. of gross area.

All walls and partitions in schools, hospitals, and places of public assemblage, over one story high, and all walls and partitions in theatres, shall hereafter be built of brick, stone, hollow or solid block, or metal lath and Portlaand cement plaster on metal studding, or other equivalent incombustible construction.

In rows of frame houses the dividing walls or partitions between houses shall be built of brick, terra cotta, concrete or other incombustible material; or they may be built of 4-in. studs, filled solidly with brick work laid in mortar, or with other incombustible material. If lath be used on such partitions, it shall be metal lath. Such dividing walls and partitions shall rest on masonry walls and shall extend to the under side of roof boards. A flush mortar joint shall be made between the roof boards and the partition. In rows of more than three houses every alternate division wall or partition shall be constructed of solid brickwork not less than 8″ in thickness.

Outside the fire limits, when any building is to be erected of brick, stone, hollow block, or concrete, that could under this ordinance be constructed of wood, the Chief of Fire Department or other designated official is hereby authorized and directed to allow reasonable modifications of this ordinance relating to brick buildings, in consideration of the use of incombustible material instead of wood.

* * * *

Manufacturers are occasionally threatened with a building code regulation which would be confiscatory in its nature and such a situation must be fought with facts. The lawmaking body should be shown not only what regulations are in force in other localities but they should also be shown evidence of the worthiness of the local products which are to be affected.

A peculiar situation developed in Richmond, Va., a short time ago. The way the matter was developed may be suggestive to other manufacturers who need assistance. The city of Richmond absorbed into its corporate limits the suburb of Brookland Park. N. J. Steigleder & Son, general concrete contractors and manufacturers of concrete block, had been doing a prosperous business. The building code of the city did not recognize hollow concrete block. Numerous houses and other buildings in which the Steigleder concrete block were used had satisfied owners and occupants, which testified at least in some measure to the right of the manufacturers to continue to exist in their line of work. Yet the building code situation threatened to put a stop to further manufacture of concrete block.

N. J. Steigleder & Son at once made plans to submit a new ordinance to the council, yet individual effort is sometimes not enough in such cases. In this particular case the manufacturers obtained letters endorsing their products from numerous users and these would be sure to have considerable weight. In addition, the company appealed at once to M. Wetzstein, of the Ideal Concrete Machinery Co.,[2] because this company's equipment was being used. A great deal of correspondence followed, resulting in placing in the hands of the Richmond manufacturers information as to building code regulations for small cities suggested by National Board of Fire Underwriters (parts of which have already been quoted) and numerous other data. In short, the appeal to the council for recognition of concrete block was based upon a mass of correspondence which evidenced a recognition of similar products in other cities. N. J. Steigleder & Son did not get all they wanted in a new code, but they did get substantial recognition. In fact, the code is very lenient in the matter of percent of absorption permitted in block, but is severe in limiting the use of block to those districts only in which frame buildings are permitted. Features of the new ordinance are as follows:

Hollow concrete building block may be used for the erection of buildings in the territory in which frame buildings are permitted when their use is approved by the Building Inspector. Buildings not to exceed three stories or 35′ in height.

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[1] *Concrete Stone Manufacture,* by Harvey Whipple, Concrete-Cement Age Pub. Co.

[2] Cincinnati

Concrete for block to be composed of 1 part standard brand of Portland cement and 5 parts aggregate, equal parts of clean, coarse, sharp sand and gravel, or crushed granite free from dirt or foreign matter, not larger than will pass through ½-in. ring. The material composing all such block shall be properly mixed and manipulated.

The use of hollow block will not be permitted in division or party walls; said division or party walls must be built solid.

The hollow space in said block shall not exceed 33% of bed area for block used in two-story buildings and 25% for block used in first story of three-story buildings. The walls or webs of the block shall in no case be less than ¼ of the height.

The thickness of walls of any building where hollow concrete block are used shall not be less than is required by law for brick walls. In computing the thickness of walls, an 8-in. block shall be considered one brick thick in wall measurements.

All concrete building block, before being used in the construction of any building in the City of Richmond, shall have attained an age of at least 4 wks.

No block shall have an average crush- in. when the block are tested, (at 28 das.) ing strength of less than 1,000 lbs. per sq. where the strength is figured on the effective net section.

Provided, that no hollow building block shall be used in the construction of any building in the city unless the maker of said block has submitted the product to the full test required by the Building Inspector, who may also require a renewal of such tests from time to time to insure that the standard and character of the work are kept up.

The following requirements must be met to secure an acceptance of the materials: The modulus of rupture for concrete block at 28 das. old must average 150% and must not fall below 100% in any case. The ultimate compressive strength at 28 das. must average 1,000 lbs. per sq. in. and must not fall below 700 lbs. in any case. The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15%, and must not exceed 20% in any case.

Bonding new to old concrete is a matter that requires the greatest care, as fresh concrete does not adhere strongly to concrete that has set. New and old concrete can be joined but the difference in the strength of such a connection is always uncertain. When concrete is being laid, there is always danger when part of the work has set over night, for instance, that the remainder of the work will not stick to the old part. Retaining walls will occasionally give evidence where one day's work ended and the next began, and frequently a crack will occur along this line.

How Design and Methods of Buying Influence the Cost of Steel Reinforcing Bars

By A. D. Mellor[1]

Although reinforced concrete is now generally accepted by engineers and architects throughout the world as a building matrial of the highest standing, the methods of handling some of the details of reinforcement design and erection show room for improvement. When we begin to teach the tyro to design in timber and steel, we impress upon him the necessity for limiting his designs to the use of such sticks and shapes as can readily be obtained in the market without extra cost. Judging from the orders for steel which the reinforcement manufacturers are called upon to fill, this axiom of design is not generally applied to concrete work. But standardization and simplification will cut costs in this line of work just as surely as in any other.

QUALITY

Let us consider first the question of the quality of the steel to be used in a concrete structure. Previous to 1910, almost every designer in concrete has his own ideas as to what quality of steel should be used in rolling the reinforcement. This did not cause any serious trouble for the mills in the early beginning of the use of reinforced concrete, but when it came to be widely used and the bar reinforcement tonnage became an important factor in the mills, there was great confusion. Separate billets had to be made for each different specification. Finally, the situation became impossible and the manufacturers conferred with the engineers for cities, railroads, manufacturers and other large users of reinforcement to see whether or not the quality specifications could be standardized. The result was the adoption of the Assn. of Am. Steel Mfrs.' Standard Specifications for Concrete Reinforcement Bars. These provide for the use of either the old-fashioned square twisted bar, or the more modern rolled deformed bar, to be made of either open hearth or Bessemer new billet steel. Under the heading of the rolled deformed bar, there are two divisions,—structural grade and hard grade, offering a choice between the medium and the harder grade of steel. This specification has now become widely adopted, because it is a good general specification. Large tonnages of this quality are constantly going through the mills, which means that orders calling for rolling under this specification will be shipped in the shortest possible time.

It is practically useless for an engineer, or architect, to try to write his own specification giving in detail the amount of carbon and phosphorus and sulphur. There are only a few men in the country who know enough about metallurgy to undertake such a task. Frequently, when the specification writer makes the mistake of treading on this dangerous ground, he makes a joke of his instructions by calling for certain bending tests and then specifying amounts of carbon and phosphorus which would make the physical properties impossible of attainment. Every specification that calls for a certain elastic limit and ultimate tensile strength and also specifies an exact amount of carbon is a joke to the steel manufacturer, because he knows that the different sizes of bars require different amounts of carbon to produce the same physical results.

Not only is it wise to use a standard specification, but it is advisable to choose the one most generally used, such as the one mentioned above. On most contracts it is found necessary to order some of the reinforcement from stock in order to get the work started, to take care of extra work, or to finish on time. As most stocks carried in this country are rolled in accordance with this standard, its use would obviate trouble when it was necessary to substitute stock material for that rolled at the mill. This is especially important in the case of public work, where endless red tape is necessary when a substitution for quality must be made.

DELIVERIES

It has already been stated that deliveries could be improved by specifying a standard quality of steel. In order to make this clear and also to explain the advantages of standardization in other ways, the handling of a bar order in the mill will now be briefly discussed.

When a mill is asked for a price and a statement as to the probable time for shipment, it will want to know:

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[1] Contract. Engr., Concrete Steel Co., N. Y. C.

(1) Quality of steel;
(2) Number of shapes and tonnage of each;
(3) Number of sizes and tonnage of each;
(4) Number of different lengths.

The average order placed with the mill is not large enough to make a rolling, but is split into units of a single size and shape, each of these units being combined with a large number of similar units from other orders. To illustrate, let us take the following single order:

15 tons 1⅛-in. square bars
20 tons ¾-in. square bars
9 tons ¾-in. round bars
10 tons ½-in. square bars
5 tons ¼-in. square bars

If this order were placed with a mill it would be split into five different parts. The first item would be combined with a large number of other items calling for 1⅛-in. square bars from other orders to make a rolling. Although the second and the third item of this order both call for ¾-in. bars, they would each be treated in the same way as the first item, because part are square and part are round bars. If the orders coming into the mill with this order called for large enough tonnages of 1¼-in., 1⅛-in., ¾-in. and ⅝-in. square bars to make rollings, our 1⅛-in. and ¾-in. squares would be rolled at once and set aside to wait for rollings of ¾-in. and ½-in. squares to be made up. The next rolling might include all of this balance with the exception of ¼-in. squares. This would mean that the ¼-in. squares would determine the speed of shipment of the entire order. Therefore, it is clear that the chances for a quick shipment decrease as the number of sizes and shapes increases.

Some engineers and architects further complicate the problem by calling for bars of odd 16th sizes, which are not much used. From what has just been said, it is clear that this very materially increases the probability of a slow shipment. This practice not only increases the number of sizes, but calls for sizes which are difficult to match with those of other orders to make a rolling. These designers are mistaken in believing that they are working closer to their calculations and cutting down the cost of the work by saving steel. By using square and round bars in ⅛-in. sizes, and bearing in mind that considerable variation in dimensions of beams and girders is possible, they could avoid these odd sizes. Also, they forget that the steel costs the contractor more because he has to pay higher size extras for these bars. This matter of extras will be taken up later under another heading. Furthermore, they do not take into consideration the fact that the bars must be identified on the work and placed by ordinary workmen who will have difficulty in selecting the proper size bar from a pile varying in size by 1/16″, and that a structure designed with such microscopic exactness may be weakened through the error of using bars 1/16″ too small. Such an error would weaken the design by from 15% to 35%, depending upon the size.

It will also be clear that if an odd quality of steel is called for, it will increase the difficulty of matching the several items of an order with similar items of other orders to make a rolling. If the quality of steel is very odd, the order would have to be rolled separately. And if the tonnage was very small and the mills were busy, the order might be indefinitely delayed.

A simple order calling for a few different lengths only will be put through the mill much faster than one calling for many different lengths. Each change in length means a setting of the gauge on the shears, which takes time. Lengths should be given in even inches, avoiding fractions. If the bars must fit in between steel I-beams, a note to that effect should be made against the items in question, so that special care may be taken. The usual practice is to shear the bars; if milled ends are required, special note of the fact should be made. Bars ⅝″ in diam. and smaller of similar lengths will be bundled by the mill. Too many different lengths tend to discourage the mills from rendering this valuable service, especially in busy times.

PRICE

From what has been said, it is clear that the ideal order would call for bars all of the same shape, size and length, rolled from steel of standard quality. This, of course, is impossible for most structures, but the nearer the designer can approach this ideal, the lower will be the price and the shorter the time for shipment. This is of vital interest to owner, designer and contractor.

Excluding bars ¾″ in diam. and larger, which are known as the "base" sizes and which take the same price, the larger the bars used the lower the cost of the steel per ton. The following size extras are added to the base price:

11/16-in.	5 cts. per 100 lbs.
5/8-in.	5 cts. per 100 lbs.
9/16-in.	10 cts. per 100 lbs.
1/2-in.	10 cts. per 100 lbs.
7/16-in.	20 cts. per 100 lbs.
3/8-in.	25 cts. per 100 lbs.
5/16-in.	35 cts. per 100 lbs.
1/4-in.	50 cts. per 100 lbs.

Bars 5′ and longer in length are cut without extra charge. For shorter lengths, the following extras apply for shearing:

Lengths over 24″ and less than 60″	5 cts. per 100 lbs.
Lengths 12″ to 24″ inclusive	10 cts. per 100 lbs.
Lengths under 12″	15 cts. per 100 lbs.

All orders calling for less than 2,000 lbs. of a size and shape are subject to the following extras:

Quantities less than 2,000 lbs. but not less than 1,0000 lbs.	15 cts. per 100 lbs.
Quantities less than 1,000 lbs.	35 cts. per 100 lbs.

MAKING CHANGES IN AN ORDER

Running a bar mill is a very complicated business. The number and size of the billets necessary to roll the various items on an order have to be figured very carefully, so that the right orders may be placed with the billet department to prevent waste and insure the proper amount of steel to fill the schedule. Changes in the customer's order would mean changes in all the instructions within the mill. This means confusion and delay. It is inadvisable to change an order, once it has been placed.

Contractors experienced in reinforced concrete work usually add about 2% in long lengths of the required sizes to take care of contingencies.

TWO BASES FOR BUYING

Almost all reinforcement is bought on the 100-lb. basis. Occasionally, an inexperienced contractor asks for a price on the lump basis, but none of the big specialists buy in this way. The explanation is simple. It is impossible to roll bars to the exact theoretical weights. All mill orders are subject to an allowable variation in weights of minus 5% and plus 2½% or 5%, depending on the mill. Owing to the close margin in steel, the seller cannot afford to take the chance of losing through a possible over-rolling. Therefore, when a lump-sum figure is made, the total theoretical weights are increased by the possible over-rolling before the price extensions are made. If the rolled weights happen to fall to the allowable minimum limit, the contractor pays from 7½% to 10% more for his steel than would be necessary if he bought on the 100-lb. basis. In other words, the lump-sum method is a game at which the buyer can not win, but may lose. Furthermore, if the buyer wants to deduct from the total amount contracted for, he does not know how much to claim, because the complication of extras makes it impossible to tell what base price was used in making the lump-sum figure.

Details of a Standard Portable Carpenter Shop on Construction Work

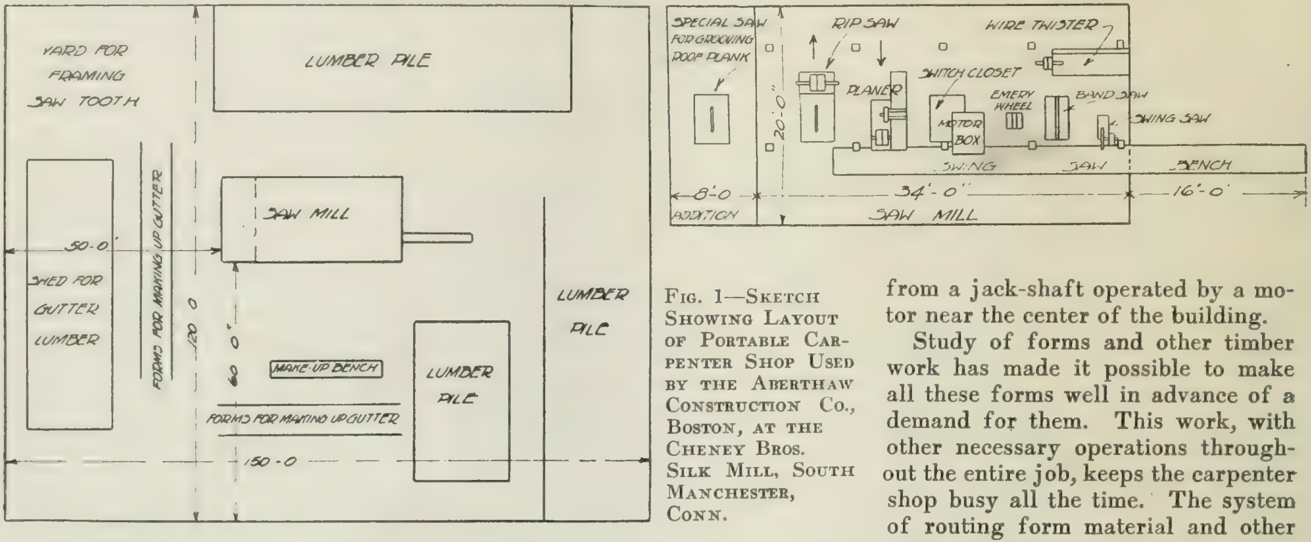


Fig. 1—Sketch Showing Layout of Portable Carpenter Shop Used by the Aberthaw Construction Co., Boston, at the Cheney Bros. Silk Mill, South Manchester, Conn.

One of the developments of the past few years in connection with building concrete structures has necessarily been a satisfactory arrangement for preparing forms and other timber. This includes all the lumber used in the construction itself, as well as that required for scaffolding, bracing and other auxiliary purposes during construction. The Aberthaw Construction Co., Boston, having made a careful study of the whole question of building and dam construction, has so standardized the carpenter shop arrangements that a single set of plans, expanded as necessary, is used for one job after another.

The principal tools shown in Fig. 3 are a swing-saw, a band-saw, South Manchester, Conn., in connection with building a new weave-shed and a new dyehouse for the Cheney Bros. silk mill. The location of the lumber piles with relation to the shop is indicated in Fig. 1, which shows also the position of all power tools used. Fig. 2 shows the construction of the open-air shop. It might be explained that the print sent out on each job for this work gives a full schedule of material, including the number of screws and bolts, as well as all the planks, studs and boards used for this purpose.

The principal tools shown in Figs. 3 and 4 are a swing-saw, a band-saw, emery wheel, planers and rip-saw. There is also a wire twister in the back of this shop. In addition to these, the shop at Cheney Bros. was given an extra saw for grooving the plank to be fitted into the roof, this being practically a cabinet-making job of building a wooden saw-tooth roof with special gutters. All of the plank used for this part of the structure were grooved and a spline driven in after being served with white lead.

The shed itself measures 34′ in length by 15′ 6″ wide. An extension of the saw-bench carries the length 16′ farther to the right, as shown in Fig. 1, while an overhanging section of the roof, 7′ wide, extends the length at the other end to cover the grooving saw. The total length of building is therefore 41′ and the length to the end of the bench 57′.

All machines are run by belting from a jack-shaft operated by a motor near the center of the building.

Study of forms and other timber work has made it possible to make all these forms well in advance of a demand for them. This work, with other necessary operations throughout the entire job, keeps the carpenter shop busy all the time. The system of routing form material and other materials has shown such good results that the usual slack times and rush times have been almost entirely abolished, the work being now a steady operation from the start of the job until it is finished. By carefully planning out in advance the location of the shop with regard to the job, and with regard also to the location of the lumber piles, much unnecessary handling of materials is avoided.

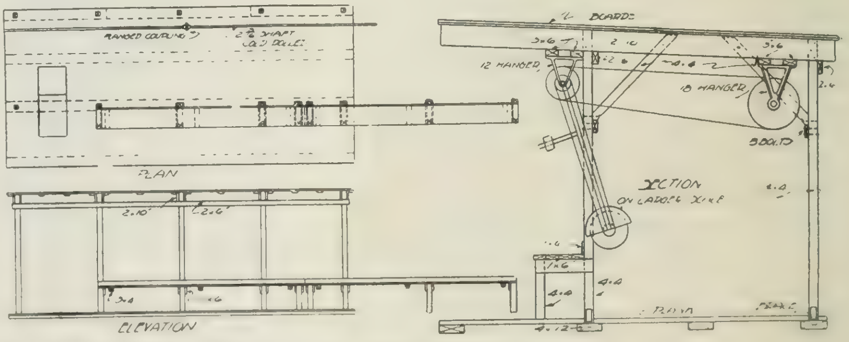


Fig. 2—Structural Details of the Open-Air Shop

Fig. 3—General View of Saw-Mill Yard—Make-Up Bench in Foreground

Field Methods in Concrete Construction—Column Forms: Design and Construction

By Jerome Cochran, C. E.

The series of articles on field methods in concrete construction, of which this is a part of the fourth, has been planned in opposition to the general assumption on the part of writers that standards or methods of construction have been established long ago and have become common knowledge. The first article on "Selection of Concrete Materials" appeared in this magazine for Jan., 1915; the second article on "Proportioning and Mixing Concrete" appeared in Feb., 1915, and the third article on "Design and Construction of Forms in General" appeared in Mar., 1915. The following article relates to the fabrication and the erection of column forms. Other form work will be discussed in a later article.

ECONOMY OF COLUMN CONSTRUCTION

The most frequently used forms in reinforced concrete are those for columns, beams and floor slabs, so that any economy effected in their design enabling their re-use without waste is sure to tell favorably in the cost of the structure. This might at first appear to be a very simple matter to accomplish, but, on a job of any size, with labor and lumber at high prices, the question of the best method of construction presents itself in an entirely different light.

Column forms should be so constructed as to permit their removal without disturbing the beam or slab forms. In removing forms the column molds are taken down first. It is therefore necessary so to design the details about the tops of the forms as to permit their removal without in any way disturbing the beam and the slab forms.

Forms built complete a full story high and concreted from the top are essential where wet and sloppy concretes are used.

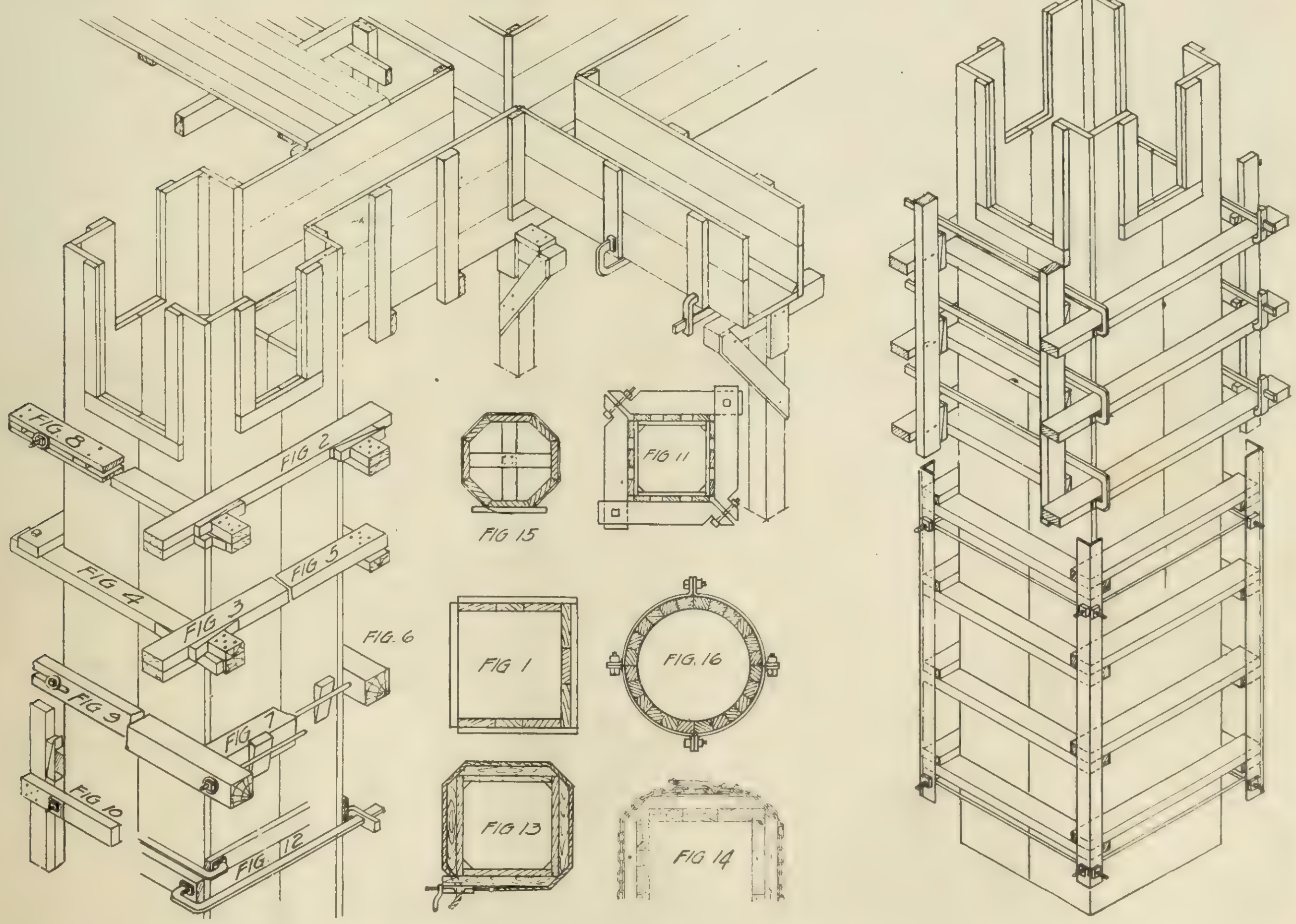
Among the many factors that play an important part in the economy of column construction may be mentioned the kind, thickness and width of lumber; the method of making forms; kind, number and method of placing braces or clamps; method of erecting, removing and transporting forms.

FABRICATION OF COLUMN FORM UNITS

Column forms should be made in units which can readily be assembled, taken apart and reassembled. The number, arrangement and size of the units are determined by the shape and size of the column and the means adopted for handling the forms.

In order to reduce the labor in adjusting different beam sizes, the tops of the column forms may be made separate from the rest of the column.

Fig. 1 shows a column form in which concrete is placed and rammed as the form is constructed. Three sides are erected to the full height and the steel is then placed. The fourth side is built up with horizontal boards as the concrete is placed and rammed. This type of column



Details of Column Braces and Form Boxes for Square, Octagonal and Round Columns form was used to some extent when reinforced concrete was first introduced, but columns are now always filled from the top and the sheathing usually is vertical.

In some cases column form units are made up of narrow strips. This is to facilitate the reduction in size of the columns from floor to floor. Each of the narrow strips represents the reduction in diameter of the column from one story to the next. For example, if the first-story column is 28″ x 28″ and the first reduction is to 26″, the next to 24″, and so on, a part of each section may be made up of strips 2″ wide, so that one strip can be taken off for each reduction.

For most columns there will be usually four units of lagging, one for each side, plus the number of yokes or collars used to bind the sides together, as shown in the accompanying illustrations. Three of the units should be nailed together before setting in place, and the fourth unit afterward. Where each unit is raised separately, one man loses time in holding the units in place, while another one nails them together.

THICKNESS OF LAGGING

Column forms vary in thickness from 7/8″ to varying greater thicknesses. They should be made up with plank not less than 1″ thick, preferably 1½″ thick.

However, for lagging, 1¼-in. and 2-in. plank are commonly used; with yokes or collars spaced 2′ apart the lighter plank is amply strong and reduces the weight of the units to be handled as well as the amount of form lumber required. The thicknesses given apply to forms built with plank run vertically.

WIDTH OF FORM LUMBER

Sometimes the dimensions of the column may be altered very slightly to permit the use of standard widths of boards or planks without splitting, the cost of the extra widths being more than made up by reduction in form cost. Boards of odd widths should be split on the power saw and not by hand.

BEVELED STRIPS

All square column forms should have diagonal or bevel strips in the corners unless the corners of the columns are protected by metal strips; otherwise they are liable to be chipped off. It is also difficult so to tamp the concrete as to make the corners perfect. The bevel strips should run the full length of column forms and should be nailed onto two opposite sides of the forms when they are made up.

OPENING AT BOTTOM OF COLUMN FORMS

Loose hand-hole caps or small removable panels should be provided at the base of all column forms sufficiently large to gain access to the inside of the form to adjust the column bars, and remove sawdust, shavings, chips and other materials that collect in the columns. The removable cap should be tacked to the column side so that it will be ready to put back in place after the column is cleaned out and before the concrete is poured.

FRAMES OR YOKES FOR COLUMN FORM UNITS

For square or rectangular columns it is usually customary to make a form or unit for each side and place around the trough thus formed horizontal frames of 2-in. x 4-in. or 4-in. x 4-in. stuff at intervals decided upon by the pressure to be resisted. Two-in. by 4-in. pieces are generally used for the frames. These frames (sometimes called bands, cleats, clamps, collars, stays, ties or yokes) are of several types, as shown in the accompanying illustrations.

Column forms may be framed or yoked with slotted scantling or bolts, or with scantling boards, or with scantlings cleated and wedged or nailed at the corners. In other words, the frames are secured in various ways, by blocks and wedges, by bolts running through the ends of the pieces, by clamps, staples, etc.

TIMBER FRAMES

Timber frames usually consist of four strips, one on each side of the column. These are held together by means of blocks or lugs and hardwood wedges, as shown in Figs. 2 and 3. On one side they may be loose, so that the same frame can be used for a narrower column by changing the position of the blocks or lugs. Other wedge details are shown in Figs. 6, 7 and 10.

A very common form of column clamp is shown in Fig. 3 where no nails are driven after the clamp is in position, thus facilitating easy removal. It is readily put in place by one man. The pieces rest on temporary blocks lightly nailed to the column forms and wedges are driven to tighten the clamp. The wedges can be easily driven up during the process of pouring concrete if any signs of giving way are noticed. The pieces are available for re-use, as they are not broken by nailing, and the wedges may be used many times.

Sometimes the four pieces are separate, but very often two pieces are nailed together to go on two sides of the column and therefore wedges are driven at diagonally opposite corners only as shown in Fig. 4. Small pieces may be used as fillers if the wedges do not fit closely enough before driving.

The four sides of the column form are sometimes tied at intervals by 2-in. x 4-in. or 1-in. x 6-in. crosspieces or frames nailed where they cross at the corners as shown in Fig. 5, instead of having blocks and wedges. Such frames as these are not of great strength, and consequently they must be placed at close intervals. The frames must also be held in some way while the connections are made. This requires two men or three men. The nails are driven vertically in a place where it is awkward so to drive nails. A superior device designed especially to consume time could hardly be produced. A practical carpenter laughs at such things, yet such designs have appeared in many advertising pamphlets.

BOLTED FRAMES

Examples of bolted frames are given in Figs. 6, 7, 8, 9, 10 and 11, the bolts usually being about 5/8″ in diam.

The space back of the bolt is frequently blocked up and wedged, as shown in Figs. 6, 7 and 10. The strips or ties exert pressure on opposite sides of the form, while the two other sides are secured by hardwood wedges between the bolts and the form. These are placed as close as possible to the ends of the bolts.

Sometimes the strips or ties of the column forms are reversed, so that the sides upon which the strips occur alternate. In this way the forms are stronger than when constructed with the strips or wooden ties all on one side.

The planks forming each side of the column box shown in Figs. 8 and 9 are fastened together by battens, and then the four sides are fastened together by slotted frames and steel tie-rods. These forms can be quickly and easily removed.

Washers should be used on all boltheads and nuts.

Fig. 11 shows a type of column brace sometimes met with in practice. Two pieces are fastened at one corner and the bolts at the other corners enable the clamps to be tightened when necessary. This clamp is decidedly inferior to the clamp shown in Fig. 9, employing rods on two sides run through slotted pieces of wood.

CLAMPED FRAMES

Heavy adjustable, wrought iron or steel clamps for clamping and adjusting all classes of forms will generally be found better than bolts or tie-rods for column boxes, as they permit rapid readjustment and removal without the use of crowbars, hammers or other tools.

The most convenient way to use clamps shown in Fig. 12 is to have pieces of wood, generally 2″ x 4″, on opposite sides of the forms, and set the clamps as shown.

The clamp is made of two pieces, the smaller having a hole slightly larger than the metal from which the larger piece is made. When the arm of the long piece is put through the hole in the small piece the two are driven snugly against the form as shown and the slight movement permitted makes the pieces lock. The greater the pressure, the tighter the hold.

Sometimes a wedge is driven in and that is really the most convenient method when it comes to taking off the clamps. No great difficulty is experienced in removing these clamps when the forms are to be taken down. The same form of clamp is used for beams and girders.

WIRE CLAMPS

There are several types of wire rope clamps on the market, one of which is shown in Fig. 13. The rope is passed around the form and can, if desired, be drawn tightly enough to bite into the wood. These clamps may be used with wood or metal forms and are convenient in use. There is great economy in using such clamps for while they cost a little more than wooden clamps they can be used over and over as many times as desired, with a minimum of labor.

CHAIN CLAMPS

Another type of adjustable clamp is shown in Fig. 14. It is intended for use in mills making round and octagonal wooden columns to hold the pieces together after gluing, but can be used also for clamping column forms in concrete work. The chain is caught in a latch which is tightened and then a handle working on a ratchet wheel is turned to tighten the chain. The chain is thrown off by simply throwing off the latch. A wire rope can be drawn better than a chain, as the links are apt to catch in the wood.

SPACING OF FRAMES, YOKES, STAYS, ETC.

Frames are placed around the sides of the column form at intervals determined by the pressure to be resisted. They must be closer together at the bottom than at the top, due to the hydrostatic pressure of the wet concrete tending to burst the forms. This is especially true when the column height is 18′ or 20′, as the hydrostatic pressure of wet concrete becomes very great in a high column and is liable to burst the forms and let the concrete out, causing considerable loss of time and material.

There is a common fault among contractors to skimp on the number of frames or yokes. Frames must be close enough together so as to allow no bulging between them, the spacing depending on the size of the columns, and the thickness of the vertical plank. They are seldom spaced over 3′ apart unless very heavy lagging is used; 2-ft. spacing for frames or yokes is common.

They are generally spaced 18″ apart near the bottom of the column form, the intervals increasing to 24″ near the top.

OCTAGONAL COLUMN FORMS

There are various methods of making octagonal column forms. They may be made up as square forms with triangular pieces inserted in the corners.

A very simple bracing for octagonal columns is obtained by beveling the eight sides of the column so as to fit together, bracing or squaring them by means of a wooden cross inside as shown in Fig. 15, removable as the concrete progresses, and tied together every 2′ or 3′ vertically on the inside by means of No. 16 or No. 18 annealed wire, which is loosely wrapped a couple of times around the circumference. A $\frac{7}{8}$-in. scantling may be inserted underneath the wire and twisted sidewise so as to tighten the wire, after which a couple of nails should be driven through the $\frac{7}{8}$-in. scantling into the side of the octagonal form.

CIRCULAR COLUMN FORMS

There are several ways by which circular columns may be constructed of wood. Sometimes the forms are built up in *half-sections,* the centering for the staves being constructed of $1\frac{1}{2}$-in. stuff, shaped to suit the radius of the column, or with straight faces, run vertically, and held together by flat ties. The two halves of the column form are held together either by means of wrought iron flat bands wrapped around the column form and properly secured with nails, or by means of heavy frames or yokes of wood to fit the outside of the narrow boards or staves; that is, with wood collars bolted together. Forms for cylindrical columns are sometimes made up in *quarter-sections,* and the forms to which the staves are nailed are sufficiently heavy to form the yoke or collar. These yokes or collars are made of about 3-in. stuff and are checked out at the corners so that they can be bolted together. They are spaced about as for rectangular columns.

Fig. 16 shows a form for round columns that has been used to some extent. Such forms should preferably be bolted together in four sections, instead of two, as some difficulty has been experienced with the two-section forms in removing them from columns 20″ in diam. The sides are usually made of 2-in. x 3-in. plank surfaced on all four sides, beveled on two, and held in place by steel bands, which may be $\frac{1}{4}$″ x $2\frac{1}{2}$″, and spaced about 2′ 6″ apart. One screw in the outer plank at each band of the several parts or sections, together with a few intermediate screws, will usually suffice to hold the plank in place.

The two methods of form construction for circular columns just described are those usually employed, but the disadvantage consists in the fact that they leave the column marked with the joinings of the staves. In other words, columns constructed with forms as shown in Fig. 16 will not have a round surface, but will consist of many flat surfaces, about $2\frac{1}{4}$″ wide. These joinings will show to much less extent if the staves have been shaped to suit the radius of the column. That is to say, if a perfectly round column is desired, it will be necessary to cut the surface of the plank next to the concrete to the desired radius.

While flat surfaces offer no objection where the column is to be plastered, and, in fact, are not really objectionable where the concrete work is exposed, in order to get very smooth columns sheet metal forms are often used for molding when the columns are to be circular in form. Wooden forms are rather clumsy affairs and are expensive to construct.

Metal forms for circular columns are made in halves or quarters of No. 16 or No. 18 galvanized sheet iron with angles along the edges for securing the several sections together. These forms are more economical than wood, especially where considerable use can be made of them; for example, when the columns are all of one diameter and there are a number of them.

In several instances in which hooped or spiral reinforcement has been used the hooping has been wrapped with, or made of, expanded metal or other meshwork, and the concrete deposited inside the cylinder thus formed, without other formwork. A moderately dry concrete is essential for such construction.

ORNAMENTAL COLUMN FORMS

Forms for ornamental columns call for special design and construction. For many purposes, such as porch and portico work, the best plan is to mold the columns separately and to erect them as stone columns of like character are erected. Metal forms may be used.

Design Methods in Concrete Construction — Analysis of Stresses in T-Beams and Design of Beams in General

By Jerome Cochran, C. E.

This is the fourth of a series of articles on Design Methods in Concrete Construction. In the first and the second article, published in this magazine for Jan., 1915, and Feb., 1915, were given, analytically and graphically, the general principles which govern the determination of the bending moments and shears in simple beams under applied loads. The analysis of stresses in reinforced concrete rectangular beams was considered in the Mar., 1915, issue. The formulas used in designing T-beams are considered in the present article, as well as the application of formulas to the design of beams and slabs. The formulas used in designing beams reinforced for compression will be considered in the next article, as well as a more detailed consideration of beam and slab designs.

For more intricate details of reinforced concrete design the reader is referred to such excellent treatises on design as Brook's Reinforced Concrete; *Hool's* Reinforced Concrete Construction, *Vol. I and II; Ransome & Saurbrey's* Reinforced Concrete Buildings; *Taylor & Thompson's* A Treatise on Concrete, Plain and Reinforced; and *Turneaure & Maurer's* Principles of Reinforced Concrete Construction.

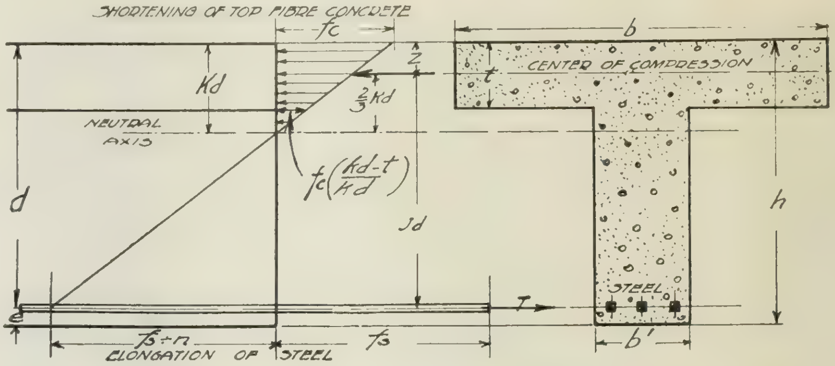


Fig. 1—Resisting Forces in a Reinforced Concrete T-Beam

ANALYSIS OF STRESSES IN A T-BEAM

In beams of rectangular cross-section the concrete below the neutral axis serves only to transfer the stress in the steel and does not possess tensile strength. Hence, considering only tension and compression, about half of the concrete is inert. The T-beam is designed to economize in this respect by concentrating the concrete, where it is most effective, near the compressive side of the beam.

NEUTRAL AXIS IN FLANGE OR AT UNDER SIDE OF FLANGE

If, in Fig. 1, the neutral axis falls within the flange, the analysis of stresses is the same as for rectangular beams, considering the T-beam as a rectangular beam of the same depth, the breadth of which is the breadth of the flange. The percentage is then based on the total area *bd*, and the value of k is $\frac{1}{1+z}$, as before, but if this be larger than the thickness of the flange, *t*, the following method is to be used:

NEUTRAL AXIS BELOW FLANGE

Assuming the compression to be distributed as shown in Fig. 1, and the steel to take all the tension, the formulas given below may be deduced in a manner somewhat similar to that given for rectangular beams in the previous article, with the following nomenclature:

fs=tensile unit stress in steel, lbs. per sq. in.
fc=compressive unit stress in concrete, lbs. per sq. in.
Es=modulus of elasticity of steel, lbs. per sq. in.
Ec=modulus of elasticity of concrete, lbs. per sq. in.
$n=\frac{Es}{Ec}$
M=moment of resistance or bending moment in general, lbs.-ins.
As=area of steel, sq. ins.
b=width of flange, ins.
b'=width of stem or web, ins.
t=thickness of T-flange, i. e., thickness of slab, ins.
d=depth of beam to center of reinforcement or distance from outside compressive fiber to center of gravity of steel, ins.
h=height or entire depth of beam, ins.
k=ratio of depth of neutral axis to depth of steel in tension or effective depth d.
kd=distance from outside compressive surface to neutral axis in beam in which the depth to steel in tension is d.
z=depth of resultant compression below top.
j=ratio of lever arm of resisting couple to depth d.
$jd=d—z$=arm of resisting couple.
e=extra thickness of concrete below steel in tension.
p=ratio of steel cross-section to that of the concrete.

For T-beams $p=\frac{As}{bd}$, rather than As divided by the actual cross-section of the beam.

The slight amount of compression in the stem or web below the intersection of the stem and flange may be neglected.

As in the case with rectangular beams using the notation given above and referring to Fig. 1, we have

$$k=\frac{1}{1+\frac{fs}{nfc}}=\frac{1}{1+z}$$

By equating the forces acting on the section

$$Asf_s=f_c\,\frac{2\,kd—t}{2\,kd}\,bt$$

Solving the two above equations for kd and eliminating fc and fs

$$kd=\frac{2\,nd\,As+bt^2}{2\,n\,As+2bt} \qquad (17)$$

The position of the resultant compression lies in the center of gravity of the trapezoid, the parallel sides of which are equal to fc and $fc\,\frac{kd—t}{kd}$ and the height to t.

The distance of this center of compression from the upper surface of the beam is

$$z=\frac{3kd-2t}{2kd-t}\,\frac{t}{3} \qquad (18)$$

The arm of resisting couple

$$jd = d - z$$

hence

$$M = As\ jd\ fs \qquad (19)$$

$$\text{or } fs = \frac{M}{As\ jd} \qquad (20)$$

and

$$M = \frac{2\ kd - t}{2\ kd}\ bt\ jd\ fc \qquad (21)$$

$$\text{or } fc = \frac{Mkd}{bt\,(kd - \frac{1}{2}t)\ jd} \qquad (22)$$

From Fig. 1, taking similar triangles, the relation between fs and fc is found to be

$$fc = \frac{fs}{n}\ \frac{k}{1-k} \qquad (23)$$

The approximate moment arm of resisting couple may be taken as

$$jd = d - \frac{t}{2} \qquad (24)$$

which changes formula (23) to

$$fs = \frac{M}{As\ \left(d - \frac{t}{2}\right)} \text{(approximate)} \qquad (25)$$

This formula gives for ordinary cases correct and safe results, but should not be used when the flange is small as compared with the stem. It assumes that the center of compression of the beam is at the center of the slab. This gives slightly high results for a T-beam with a very thin flange in proportion to the dimensions of the web, and too low results for a shallow T-beam with thick flange. Ordinarily the error is so slight as to be inappreciable.

For approximate results, the formulas for rectangular beams may be used.

FORMULAS FOR COMPRESSION IN THE STEMS OF T-BEAMS

In the above formulas the compression in the stem is neglected. The following formulas take into account the compression in the stem and are derived by the same principles used in derivation of formulas in the previous analysis. They are recommended for large beams, where the stem forms the larger part of the compressive area or when the flange is small compared with the stem.

Position of neutral axis,

$$kd = \sqrt{\frac{2nd\,As + (b-b')t^2}{b'} + \left(\frac{nAs + (b-b')t}{b'}\right)^2} - \frac{nAs + (b-b')t}{b'} \qquad (26)$$

Position of resultant compression,

$$z = \frac{(kdt^2 - \frac{2}{3}t^3)b + [(kd-t)^2 + (t + \frac{1}{3}(kd-t))]b'}{t(2kd-t)b + (kd-t)^2 b'} \qquad (27)$$

Arm of resisting couple,

$$jd = d - z \qquad (28)$$

Moment of resistance,

$$M = As\ jd\ fs \qquad (29)$$

$$M = \frac{fc}{2kd}\left[(2kd-t)bt + (kd-t)^2 b'\right] jd \qquad (30)$$

Fiber stresses

$$fs = \frac{M}{As\ jd} \qquad (31)$$

$$fc = \frac{2Mkd}{\left[(2kd-t)bt + (kd-t)^2 b'\right] jd} \qquad (32)$$

DESIGN OF A RECTANGULAR BEAM

An analysis of rectangular beams was given in Concrete-Cement Age for Mar., 1915, and the reader is referred to the discussion of the theory there given and the derivation of the formulas. For convenience in reference, the formulas are here repeated as follows:

Position of neutral axis,

$$k = \text{the square root of } 2\ pn + (pn)^2 \text{ minus } pn \qquad (A)$$

Arm of resisting couple,

$$j = 1 - \frac{1}{3}k \qquad (B)$$

(For $fs = 15{,}000$ lbs. to $16{,}000$ lbs., and $fc = 600$ lbs. to 650 lbs., k may be taken at $\frac{3}{8}$).

Fiber stresses

$$fs = \frac{M}{As\ jd} = \frac{M}{pj\ bd^2} \qquad (C)$$

$$fc = \frac{2M}{jk\ bd^2} = \frac{2\ pfs}{k} \qquad (D)$$

Steel ratio, for balanced reinforcement,

$$p = \frac{1}{2}\ \frac{1}{\frac{fs}{fc}\left(\frac{fs}{nfc} + 1\right)} \qquad (E)$$

Having computed the maximum bending moment due to the loads in accordance with the principles given in Concrete-Cement Age for Jan., 1915, and Feb., 1915, the breadth of the beam, b, is assumed (see Fig. 2) and the depth of the steel is found from the following formula:

$$d = C \text{ into the square root of } \frac{M}{b} \qquad (F)$$

where C is a constant for any given concrete and steel.

$$As = p\ b\ d \qquad (G)$$

The constants C and p to be substituted in the above formulas may be taken from the tables on pages 519 and 520 of Taylor & Thompson's *Concrete, Plain and Reinforced*, to which the reader is referred.

For a working compression in the concrete of 650 lbs. per sq. in., a working pull in the steel of 16,000 lbs., and a ratio of modulus of steel to concrete of 15, for concrete having a compressive stress in cylinder form of 2,000 lbs. per sq. in. at 28 das.

$$d = \frac{1}{10} \text{ into the square root of } \frac{M}{b} \qquad (H)$$

or more exactly,

$$d = 0.096 \text{ into the square root of } \frac{M}{b} \qquad (I)$$

$$A = .0077bd \qquad (J)$$

Example: What depth of beam having a span of 20′ and what area of steel are required, using the above unit stresses, for a freely supported beam with a load of 1,000 lbs. per running ft.?

Solution: Bending moment, M, for $\frac{Wl^2}{8}$ is $\frac{1000 \times 20 \times 20 \times 12}{8} =$ 600,000 lbs. ins. and using formula (H) we have

$d = \frac{1}{10}$ into the square root of 600,000 divided by 8 = 27.4 ins. or say 28 ins. With 2″ of concrete below the steel, the total depth of beam is thus 30″.

The area of steel from formula (J) where the width of beam is taken at 12″ is $A = .0077 \times 12 \times 28 = 2.59$ sq. in., thus requiring two ¾-in. and two ⅞-in. square bars, or their equivalent.

The steel must also have sufficient bond and in many cases inclined or vertical reinforcement is required as will be treated in connection with diagonal tension in another article. Continuous beams also require reinforcement over the supports and will also be considered in another article as well as the selection of bending moments to use in their design.

For a beam with about 0.8% of horizontal steel (in which case, tension in steel fs is about 16,000 lbs. per sq. in. and the compression in concrete fc about 650 lbs. per sq. in.) the distance between the centers of compression and tension jd, is about $\frac{7}{8}d$ and formulas (C) and (D) given above may be expressed with scarcely appreciable error as

$$fs = \frac{M}{0.87\ Asd} \qquad (C_1)$$

$$fc = \frac{6M}{bd^2} \qquad (D_1)$$

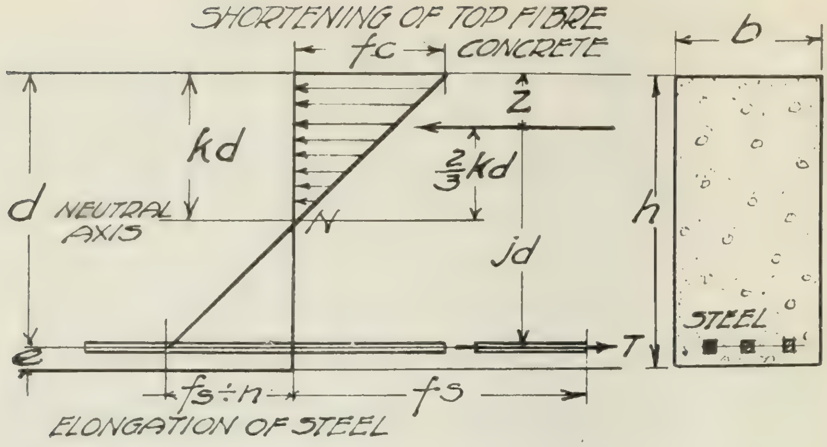


FIG. 2—RESISTING FORCES IN A REINFORCED CONCRETE RECTANGULAR BEAM

DESIGN OF SLABS

The depth and the percentage of steel for slabs are obtained by the same formulas as those used for rectangular beams, the bending moment being figured for a width of slab equal to 1′.

Substituting 12″ for b in formulas (H) and (J), we have

$d = 0.29\ C$ into the square root of M (K)

$As = 12\ p\ d$ (L)

For $fc = 650$ lbs. per sq. in., $fs = 16{,}000$ lbs. per sq. in. and $n = 15$, we have by substituting the corresponding value for C from Table 10, p. 519 of Taylor & Thompson's *Concrete, Plain and Reinforced,* in the above formula

$d = 0.028$ into the square root of M (M)

$As = 0.092\ d$ (N)

DESIGN OF T-BEAM

Where slabs and beams are cast together a portion of the slab may be considered as part of the beam forming a T-section. This increases the available compression area and permits the use of a larger percentage of steel than that allowed in rectangular beams.

Theory of T-Beams—The theory of T-beams requires that the total internal pressure be equal to the total tension or pull in the steel. In case the design is unbalanced so that the T-beam is stronger in compression than in pull, the strength of the T-beam is limited by the safe moment of resistance determined from the allowable tension or pull in the steel. If, on the other hand, the tensile resistance is greater than the compressive resistance, the concrete governs the strength of the T-beam. The failure of T-beams is usually due to lack of sufficient steel rather than to compression of the concrete. A T-beam must be deep enough to prevent over-stressing concrete in the flange.

Width of T-beams—The width of T or tributary part of the slab, b, to use for the flange of the T-beam in compression is selected somewhat arbitrarily. In no case of course can it be taken greater than the distance between beams. It should not exceed the following limitations[1]:

(1) The maximum width of the T shall not be greater than 1/3 of the clear span.

(2) No T shall be considered as projecting more than five (5) times the thickness of the slab on either side of the stem.

(3) The width of the T shall not exceed five (5) times the width of stem.

The Joint Committee recommends that the effective width shall be determined by the following rules:

(a) It shall not exceed ¼ of the span length of the beam.

(b) Its overhanging width on either side of the web or stem shall not exceed four times the thickness of the slab.

Beams in which the T form is used only for the purpose of providing additional compression area of concrete should preferably have a width of flange not more than three times the width of the stem and a thickness of flange not less than one-third of the depth of the beam. Both in this form and in the beam and slab form, the web stresses and the limitations in placing and spacing the longitudinal reinforcement will probably be controlling factors in design.

Cross-Section of Stem—The width of the stem of a T-beam is governed by the layout of the tension bars and by a study of the shearing stresses, a subject to be discussed in another article.

Minimum Depth of T-beam—The minimum depth is the depth at which concrete and steel are stressed simultaneously to their working limits, but greater depth than this is generally used, for economical reasons.

The minimum allowable depth for T-beams may be found from a folding diagram in Taylor & Thompson's book, p. 525. If preferred, the rectangular beam formulas (C and D) may be used where the depth of the beam is not greater than four times the thickness of slab, using in this formula the width of the flange, b, for the width of the beam. For ratios of the depth of T-beams to thickness of slab larger than 4 the rectangular beam formula gives unsafe results and the formulas previously derived for T-beams should be used.

Economical Depth of T-beam—Greater depth than the minimum is generally used for economical reasons as previously mentioned, because deepening the beam reduces the area of steel proportionately. The following formula is given in Turneaure & Maurer's *Principles of Reinforced Concrete Construction,* p. 238:

$$d - \frac{t}{2} = \text{the square root of } \frac{r\,M}{fs\,b'}$$

where r = ratio of unit cost of steel in place to unit cost of concrete in place (using same units for steel and concrete).

The other notation is the same as that already given under T-beams.

The most suitable depth of T-beam may be selected from this formula after two or three trial computations for different widths of stem. The ratio of costs, r ranges between 38 and 75, the usual value being taken at 60 where no unit costs are given.

The depth of the T-beam should bear some definite relation to the width of stem. Many designers make this ratio between 2 and 3. A ratio of 4 may be used for very deep and large beams, while, for cases where the head room is limited, this ratio be even less than 2.

The depth of T-beam is sometimes made an arbitrary ratio to its span. The average ratio of span to depth of beam is about 10 to 12 or the depth in inches approximately equal to the span in feet.

Sectional Area of Steel in T-beams—The area of cross-section of steel in tension may be obtained very closely by formula (25). For more exact computations, formula (23) should be used. An inexperienced designer should check his results obtained by approximate formulas by the more exact ones.

Details of Design—The design of a T-beam must also be studied for shear reinforcement, bond of steel to concrete, and especially for the design at the support, which must be adapted to the negative bending moment. These details will be discussed in another article.

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[1] Cochran's *General Specifications for Concrete and Reinforced Concrete,* p. 179

Notes on Equipment of a Concrete Brick Plant in Hospital Broom Shop

By Harvey E. Jenks

In the Mar., 1914, issue of this magazine Mr. Jenks described some preliminary work in concrete products manufacture—particularly brick—at the Norfolk State Hospital, Norfolk, Mass., as a means of utilizing hospital patients in work beneficial to them and providing at low cost for building construction. In this second article Mr. Jenks takes up the work done when products made by hospital patients had developed to that point at which their manufacture was regarded as being of real importance by the Board of Trustees. Mr. Jenks wastes no words, but launches at once into a description of the layout, equipment and operation of a factory on the lower floor of the hospital broom shop.

Upon the completion of the remodeling of the lower floor of the broom shop building machinery was installed and located as shown in the accompanying illustrations.

A sand heater was installed outside the building and sand was wheeled to power screen.[1] This is a two-section screen—the first section screens to ¼-in. size and the second to ⅝-in.; and other desired mesh can be quickly applied. All sand passing the ¼-in. screen was used in making brick while that passing the ⅝-in. screen was used for making fence posts, and the tailings were saved for summer use on sidewalks and other outdoor work, very little of the stone beeing too large for ordinary work. By this method enough stone was secured from the brick plant to do all our outside concrete work and it became a valuable by-product, saving us $1.50 per ton for crushed stone.

After screening, the sand was shoveled into a sheet iron charging bucket holding 1 cu. ft. as shown in the accompanying sketch, and carried to the Miracle[2] cube mixer which was operated by power. These buckets are of a very convenient shape and size for charging small mixers and can be obtained at a nominal cost from any concern dealing in iron goods.

The cube mixer cost $115 with hand power and $15 extra for pulley ment, and would handle 5 cu. ft. of mixed concrete to a batch, which was ample to supply the Helm No. 5 brick machine.[3] This machine has a rating of 12,000 brick per da., and cost $450, with $75 extra for power attachments. As will be noted on the plans, the brick were taken directly from the press and placed on cars in waiting, which when loaded were run out onto a transfer car, thence to the curing room where they were allowed to remain 3 das., when the cars were run to the yard and unloaded.

These cars were built by ourselves. Each car required: four 12-in. roller-bearing wheels, 24-in. ga., two axles, four bearing blocks and four U bolts, all of which can be purchased for about $8.00 or a little less, and give a truck with a capacity of 5,000 lbs. To complete a car such as we used the following matrial is required:

2 pieces of oak 3″ x 6″ x 8′ 3″ long.

3 pieces of oak 3″ x 3″ x 2′ 9″ long.

4 pieces of spruce 1″ x 3″ x 7′ 3″ long.

sketch, each rack holding 150 brick,

This material makes a car 2′ 11″ wide and 7′ 3″ long as shown in sketch, and it will hold 30 pallets with five brick to the pallet, making 150 brick on a platform. Five racks were made for each car as shown in sketch, each rack holding 150 brick making a total of 900 brick per car. Wet brick with pallets weigh nearly 6 lbs. each. This just about loads the car to the rated capacity of 5,000 lbs. To make each rack requires the following material:

3 pieces of spruce 2″ x 6″, 2′ 11″ long.

6 pieces of spruce 1″ x 3″, 7′ 3″ long.

2 building pins 4″ long.

The building pins are set in the upper edge of the 2-in. x 6-in. pieces and holes bored in the lower edge to receive the pin from the rack underneath, doing away with any danger of the racks falling off the car through careless piling or other causes.

These cars were also useful to carrying fence posts which were

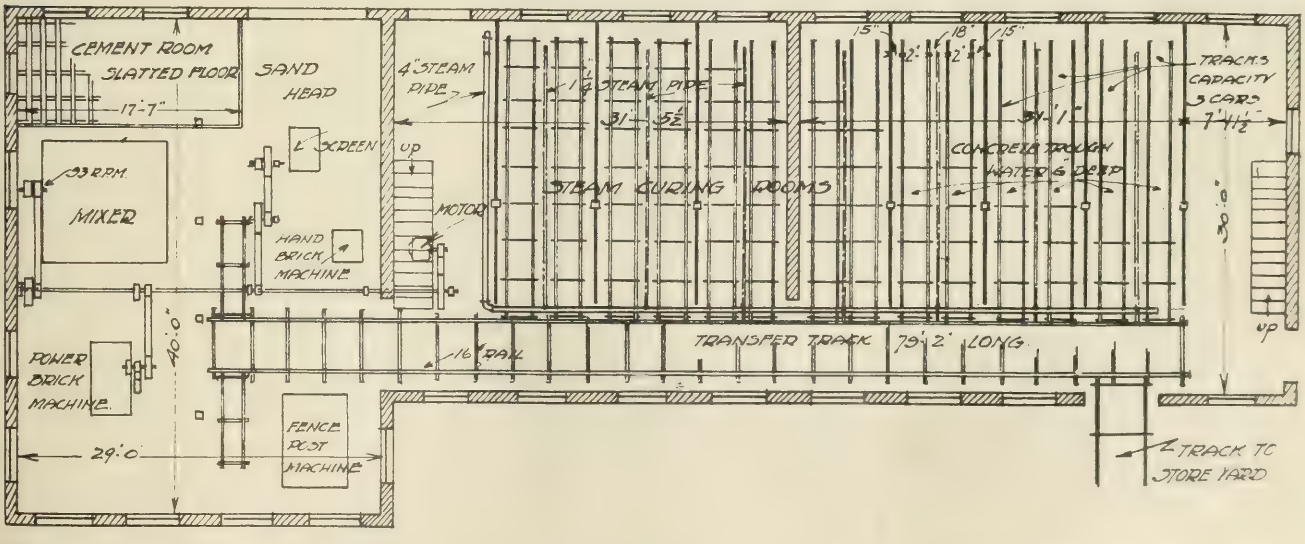

Fig. 1—Plan of Broom Shop as Arranged and Equipped as a Concrete Products Plant, Norfolk State Hospital, Norfolk, Mass.

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[1] Cement Tile & Mchy. Co., Waterloo, Ia.

[2] Lansing Co., Lansing, Mich.

[3] The Helm Brick Machine Co., Cadillac, Mich.

FIG. 2—PARTIAL LONGITUDINAL SECTION OF PLANT

made 7′ long, by simply placing a 1-in. strip across each end, and would even carry an 8-in. corner post, but instead of using the racks, a piece of board was placed across each end of the molds and the posts piled on top of the other; these posts weighed, with the mold, nearly 100 lbs., and were piled five wide and 10 high, making about 5,000 lbs.

Seven curing rooms were built holding six cars each and two rooms were filled each day with brick and other products. To equip this plant then required the following:

44 cars as described above, 220 racks as described above; 6,600 cypress pallets 7/8″ x 8″ x 12″, grooved at each end and a 1/4-in. strip inlaid to keep them free from warp.

The extra curing room and cars were provided to allow the yard men to get the first room cleared during the forenoon when bad weather interfered and yard tracks had to be cleared of snow and ice.

These same cars will accommodate any pallet carrying 10 brick but three extra racks have to be provided to carry 900 brick; sewer pipe and tile can be handled by supplying boards to fill in the spaces.

To complete the curing room equipment the following was purchased:

165′ of portable track, 12-lb. rail, 24-in. ga.	$ 63.80
2 curved sections track 12-lb. rail 24″ gauge	16.95
630′ of 12-lb. rail 22′6″ long	51.25
165′ of 16-lb. rail for transfer car	19.75
400 lbs. 3½ in. x 7-16-in. spikes	15.70
1 4-ft. 8½-in. ga. transfer car	19.70
Total f. o. b. our siding	$195.45

The portable track was used from the curing rooms to yard, while the track in the curing rooms and transfer track were spiked to 4-in. x 6-in. spruce stringers laid on brick piers 8′ o. c.

As our exhaust steam was all used in the heating system, live steam was supplied through a 4-in. pipe and reduced to 5 lbs. pressure; this pipe fed a 1¼-in. pipe at each curing room which was perforated with a ¼-in. hole every 12″ and ran through a trough of water, giving a generous supply of wet steam maintained at a temperature of from 100° F. to 120° F. Thermometers with an extension bulb which passed through the doors of the curing room were supplied, as were also tell-tales at the water trough, making it unnecessary to open the doors after the cars were placed until they were removed.

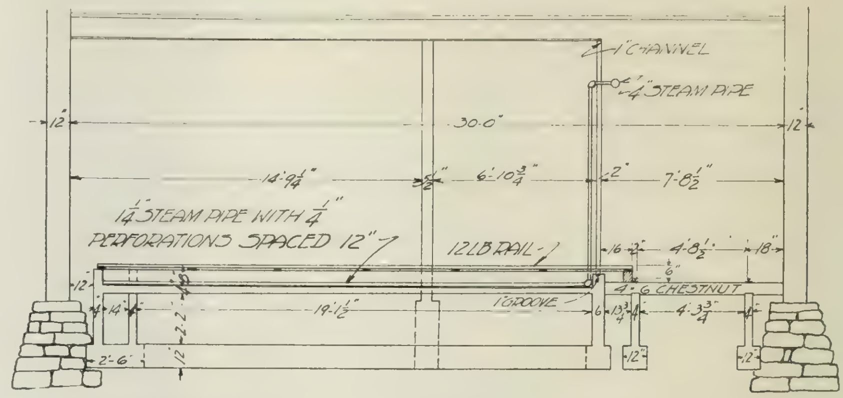


FIG. 3—STEAM CURING ROOM, TYPICAL SECTION

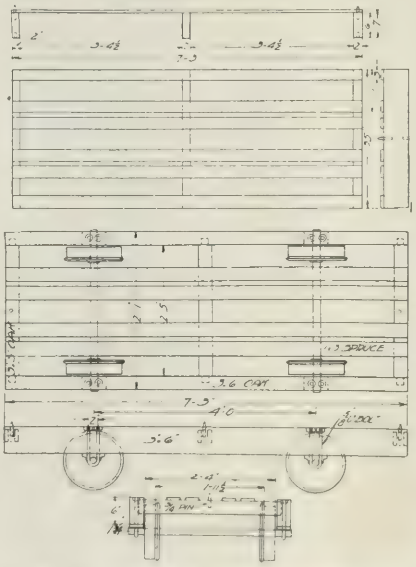


FIG. 4—DETAILS OF BRICK CAR AND RACKS

A 10-h.p. electric motor furnished all the power required and this, as well as a large part of the shafting, pulleys, belts, etc., was on hand and costs are not available. However, a little study of the plans with the foregoing information will enable anyone to get the cost of entire equipment in his own particular locality.

The description of the plant is not intended to show a model layout, but rather to ilustrate what could be done with a building already on hand. Two solid partitions and numerous posts carrying upper story interfered somewhat with the arrangement and necessitated slight differences in dimensions of the curing rooms.

However, it has served its purpose admirably and with modifications would answer very nicely as a moderate sized plant. The curing rooms are higher than need be and should be arched in order to carry the water caused by condensation down the side walls, instead of being allowed to drip onto the fresh product. This annoyance in our case was not serious; being our own customers, we were able to use the top layer which had become pitted by the water dripping, in manholes or for backing in minor buildings erected by ourselves.

In conclusion I wish to emphasize the fact that the manufacture of brick or any other concrete products is a real industry, demanding a considerable expenditure of money and a thorough knowledge of materials to be used. This is especially true regarding sand or aggregate.

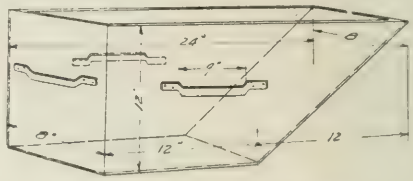


FIG. 5—DETAIL OF CHARGING BUCKET

The question of aggregate and proper uses of cement and aggregate then becomes vital. A prospective manufacturer will do well to be sure he has a pit-boss who understands the difference between a good, clean sand and sand mixed with clay or loam which may have run down from the top of an improperly stripped bank, as well as at least one competent man at the plant in continuous attendance.

Brick made on the Helm press are

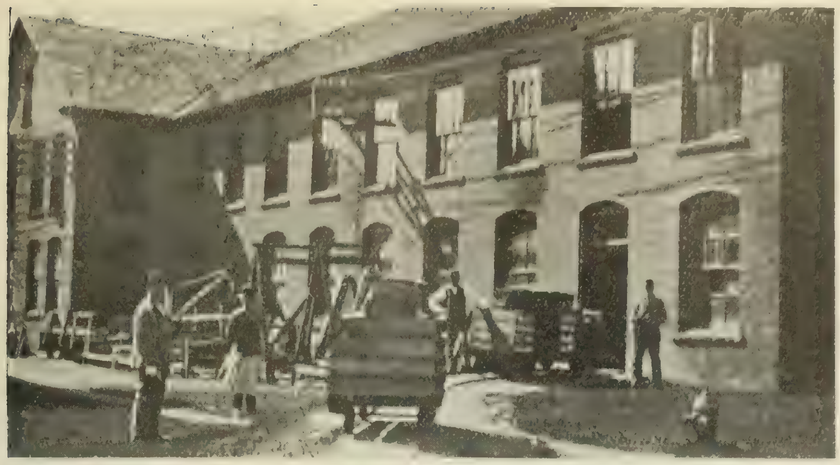


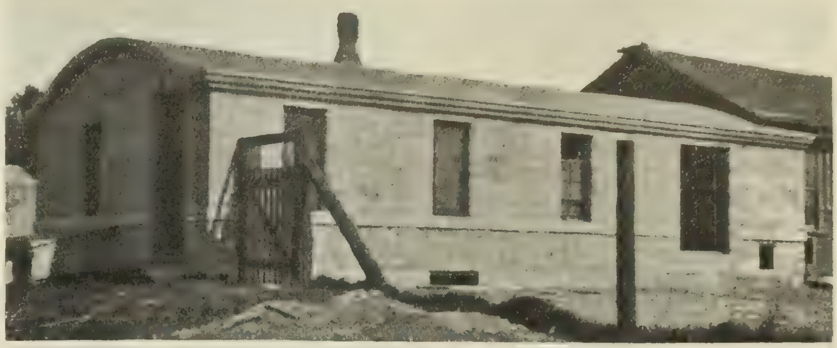
Fig. 6—Exterior View of Plant, Showing Cars with Racks

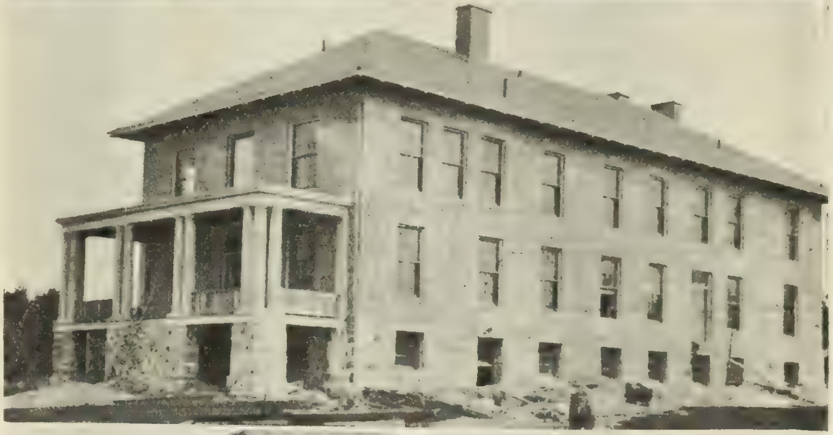
2" x 4" x 8" and are somewhat smaller than those made on the Miracle hand machine on which our first brick were made. Last year Lehigh[4] cement was used, costing $1.45 per bbl. in paper sacks, making brick cost $3.50 per M for cement used; $2.00 per M was paid for carting 3½ mi. to new buildings, making a total cost of $5.50 per M delivered on the job as against $14 per M for a good quality of hard burned clay brick delivered to nearest freight siding 1 mi. away. These brick have been used in the erection of new buildings, sewer systems, etc.

The Administration building is 40' x 90' and consists of a basement and two full stories. Two hospital buildings 33' x 65', each 2 stories and basement, were erected one on either side of the Administration building and 90' distant.

These three buildings are so designed as to be ultimately connected, should occasion or necessity demand, making one structure of the three. There is also ample room to erect more hospital buildings at either side. A cottage 27' x 37' for paroled patients has been completed on an elevation at the rear. Ten other cottages of similar design, a chapel and a central dining hall are planned for this location. The four buildings are of similar construction, field stone being used for the basements and concrete brick for the walls of the buildings, including all partitions and chimneys. A one-story Industrial building containing shops for carpenter, machinist, plumber, electrician, painter, shoemaker, upholsterer, etc., and a one-story laundry building were also built of concrete brick with field stone foundations. A Service building 50' 8" x 105' 8" was located on a side hill, with the lower floor at grade and the upper floor at the height of a delivery platform and car platform above grade. The power plant, 52' x 75', is also located on the same side hill with the engine room on a level with the lower floor of the Service building. A one-story laundry building 48' x 60' lies adjacent to the power plant. These four buildings are all flat roof and covered with Barrett roofing.[5]

Cinders for fireproofing work should be chosen carefully, as the presence of unburned coal will render concrete containing it the least fireproof, whereas it is supposed to be the most fireproof.





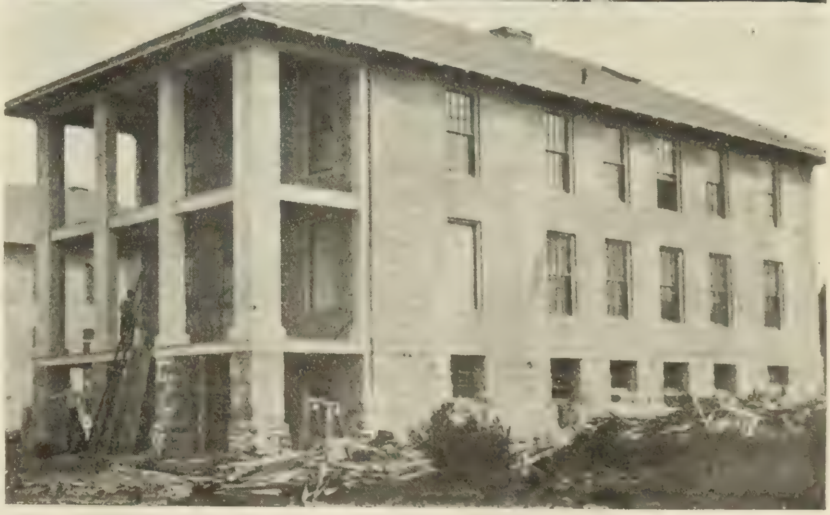


Fig. 7—Brick Hennery with Concrete Roof

Fig. 8—Front View Administration Building. Built of Concrete Brick

Fig. 9—Front View South Hospital, Built of Concrete Brick

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[4] Lehigh Portland Cement Co., Allentown, Pa.

[5] Barrett Mfg. Co., N. Y. C.

Righting the Tilted Grain Elevator of the Canadian Pacific Ry.

In the Dec., 1913, issue of Concrete-Cement Age, p. 259, the subsidence of a group of 65 large cylindrical reinforced concrete storage bins 100′ in height, with a capacity of 1,000,000 bus. of grain in connection with the Canadian Pacific Ry. elevator at North Transcona, six mi. east of Winnipeg, was described. These storage bins, which rested on a reinforced concrete slab, settled and "tipped over" about 27° from the vertical, as shown in Fig. 1. The ground displaced by this movement was thrown up into a mound of earth nearly 25′ high, while the foundation on this side sank 20′ into the ground. The bins were, it was said, without a crack, structurally intact; and plans were made to underpin the group of bins and jack it back into position. A brief report of the progress in straightening this structure, which originally stood as shown in Fig. 2, was given in Concrete-Cement Age for June, 1914, p. 269. We are now able to give some information as to the methods employed in actually righting the elevator.

When the structure sank it was loaded with about 875,000 bus. of grain. The first step necessary was to remove this load, and in order to do this holes were cut in the concrete sides of the bins. Dec. 1, 1913, the work of straightening the structure was started.

THE UNDERPINNING WORK

The scheme adopted consisted in sinking concrete piers 7′ in diam., spaced approximately 15′ c. to c., to rock to form a secure foundation, and by excavating beneath the high side the structure was righted, coming to rest on these piers, but at an elevation lower than its original level. It was carried out as follows:

A trench was dug along the high side and the ends of the elevator and carried to a depth sufficient to permit excavation to be carried on underneath the reinforced concrete slab. Work was then started on sinking the line of piers along the low side of the building, it being the intention to block the structure temporarily from these piers so that it would form a fulcrum about which the elevator might be rotated some 16°. The earth from the excavations was carried away on belt conveyors and dumped into wagons.

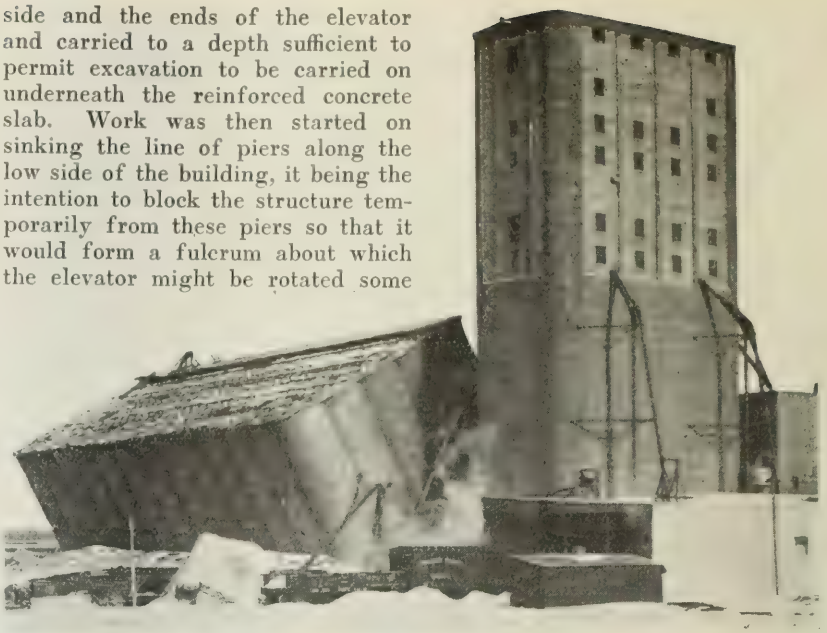


Fig. 1—A General View of the Tilted Grain Elevator, Showing the Tops of the Tanks. At the Right is the Working House

(Reproduced from Concrete-Cement Age, June, 1914, p. 269)

In order to sink some of the piers it was found necessary to get inside the concrete bins, and cut holes through the bottom. Through these holes the excavations were made and the concrete placed.

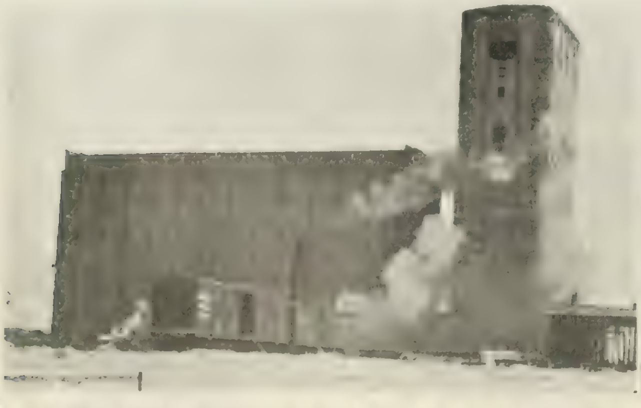
After the elevator had been straightened to a position at which it was only 18° out of plumb, jacks were introduced on the low side and the structure supported in the center by an oak rocker for a turning point, resting on a concrete pier. By jacking up on the various rows of concrete piers, the huge structure was gradually brought back to its vertical position.

In order to raise the great weight of the structure, about 20,000 tons, special jack-screws of herculean proportions were necessary, and during the progress of the work there were more than 400 of these resting on the tops of the foundation piers. A gang of men was appointed to handle each battery of screws and they were worked in unison.

NEW POSITION OF RIGHTED BIN HOUSE

Fig. 3 shows a view of the elevator after being righted. Comparing this view with that shown in Fig. 2, it will be noted that the structure is at a much lower elevation than its original level, the top of its roof now being about on a level with the lower window sills of the working house, which, strange to say, was not seriously affected by the movement of the soil under the bin house.

The underpinning and straightening operations were carried out by The Foundation Co., Ltd., Montreal, P. Q., and Vancouver, B. C., Can. The work was carried out under the direction of J. G. Sullivan, Chf. Engr. of the Canadian Pacific Ry. (at Winnipeg).



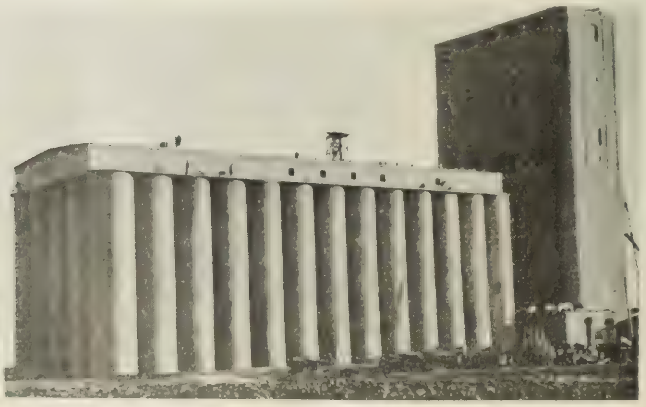


Fig. 2—The Storage Section of Bin House of the Grain Elevator as Originally Built. At the Right Is the Working House

Fig. 3—The Grain Bins in Righted Position

Shoring a Large 9-Story Building During Freezing Weather at Detroit, Mich.

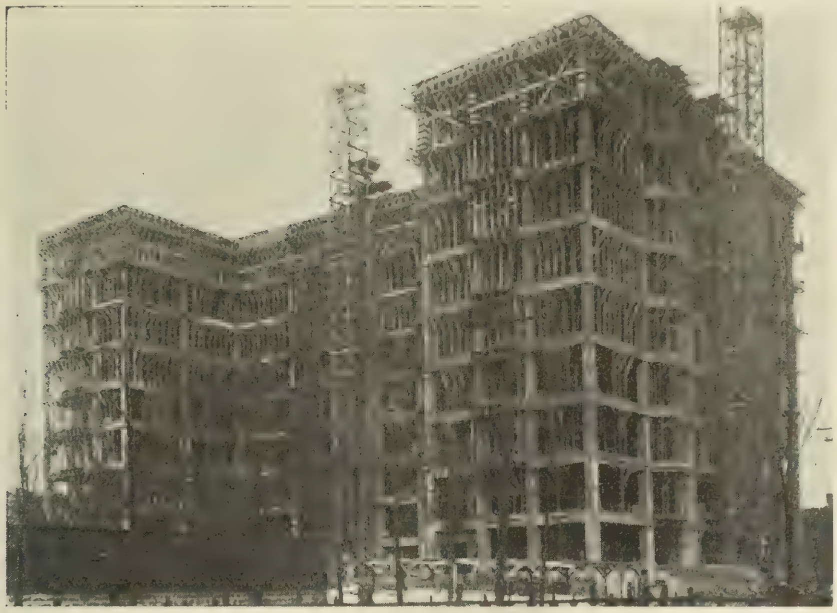


Fig. 1—The Garden Court Apartments, Detroit

Form work for the entire building was erected complete before any shores were removed

The accompanying illustrations show a very interesting feature in connection with the concrete work on the Garden Court Apartments in Detroit in the winter of 1914-1915. The building is about 107′ wide, 185′ long and contains two wings, each measuring about 40′ x 40′. It is 100′ high and has about 147,000 sq. ft. of floor surface. The concrete framework was designed along the lines of standard practice. The floors are of Floredome[1] construction as shown in Fig. 2.

Form work for the entire building was erected complete before any stripping was done (see Fig. 1), no shoring whatever being re-used. The reason for doing this was the installation of one floor every 5 das. and as an extra precaution, due to the fact that the concrete roof was poured 2 wks. before any stripping was begun.

There were 14,000 pieces of 4-in. x 4-in. studs, 10′ long, used for shoring, being spaced from 3′ to 4′ o. c. as shown in Fig. 2. To the uprights were nailed 2-in. x 6-in. planks, which supported 2-in. x 6-in. joists, spaced from 2′ to 2′ 6″ o. c. The joists supported 1-in. x 6-in. planks spaced 2′ o. c., which in turn supported the steel Floredomes used as centering for the joist floor construction.

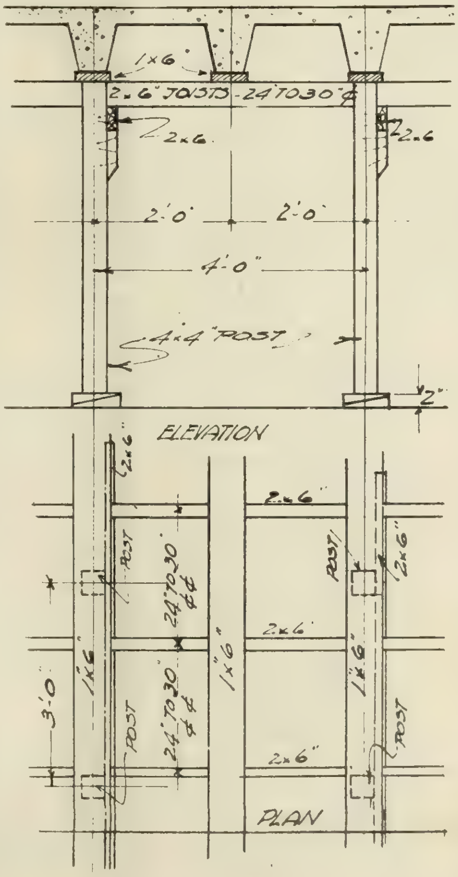


Fig. 2—Sketch Showing Details of Form Centering Used on the Garden Court Apartments, Detroit

The particular type of metal forms ordered for the job was found to be unsatisfactory for the large columns in the basement and the ground floor. For columns 26″ x 26″ in size and up, the metal forms bulged badly at the bottom, due to the hydrostatic pressure of the wet concrete and to the frail construction of the forms. They were soon discarded after pouring several columns, and not even tried for the smaller columns in the upper stories.

The concrete work was protected from freezing by enclosing the building with canvas and keeping salamanders burning for three days after placing the concrete. It cost about $10 per da. to operate these salamanders on each floor.

We are indebted for these data to Frank Roller, mgr. of the Detroit office, Irwin & Leighton, bldg. contrs. who erected the building.

As to whether or not dirt in sand is harmful depends upon the character of the dirt. The kind of impurity is really of more importance than the quantity. The presence of a small amount of clay in sand does not as a rule weaken or injure mortars or concretes, but it is generally considered that the presence of loam or dirt is objectionable.

The careful sorting out of steel reinforcing on the job not only tends to promote economy, but also largely assists and facilitates the work when it is necessary to begin the operation of bending and placing.

Molds for concrete newels, finials, rails, balusters, spindles, balls, caps and bases for piers, etc., should be so constructed that they can be removed piece by piece without injuring the casting. Their strength and rigidity must be ample to withstand without distortion tamping and other strains.

All forms should have ample strength to support properly the loads they are called upon to carry. They must be strong enough to retain wet concrete, or they must be strong enough to withstand the pressure due to tamping in case a dry concrete is used. Loads of forms must be restricted to those for which the forms are designed, namely, the weight of the concrete and such construction loads as are necessary, like the weight of workmen, runways, wheelbarrows, etc. Storage on the forms of construction materials for future use should not be permitted.

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[1] Trussed Concrete Steel Co., Youngstown, Ohio

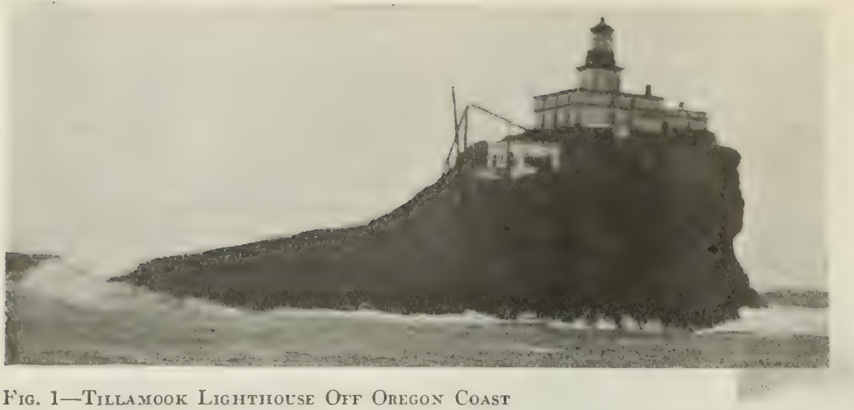

FIG. 1—TILLAMOOK LIGHTHOUSE OFF OREGON COAST

Concrete Superseding Wood in Lighthouse Construction

By Jas. G. McCurdy[1]

Even up in the Pacific Northwest where lumber is plentiful and reasonable in price, concrete is rapidly coming to the front as a building material. The trend of the times is shown in the action of the Lighthouse Board of the 13th District (comprising Oregon, Washington and Alaska) in recently constructing two lighthouses entirely of concrete. Plans are being formulated for another new lighthouse on Robinson Point, and this will also be of concrete; in fact it is commonly understood that the day of wooden lighthouse construction is past.

Concrete in this particular field costs more than brick or lumber, but it is more rigid and permanent than either and seems ideally adapted to the needs of the lighthouse department, where buildings are constantly exposed to the full force of the elements.

The custom of projecting the light-tower through the roof of the keepers' dwelling will also be done away with. Hereafter the keepers' dwelling will be separate from the building housing the light and signal. Under the old system the fog-signal was located in a structure by itself and in thick weather the keepers were kept hurrying back and forth between the light and the signal. The vibration of the tower causes numerous leaks to develop, while the roar of the wind about the lofty structure proved nerve-wracking to the keepers and their families.

One of the first uses of concrete by the Lighthouse Board on the Pacific coast on a large scale was in the reconstruction of the famous Tillamook Rock Light, lying off the Coast of Oregon, (shown in Fig. 1). This building was originally constructed entirely of blocks of stone dove-tailed together, with brick tower.

The lantern stands 138′ above the sea level. Yet in a terrific storm in 1894 huge rocks were sucked up from the bed of the sea by the huge waves and hurled against the lighthouse. Eleven large plates of glass encasing the light were broken, the light tower flooded and great holes torn in the structure.

In order to strengthen the lighthouse and provide against contingencies of this nature, a second story of concrete was added to the original building, and the structure strengthened throughout with this substantial material.

The first lighthouse in the 13th District to be built entirely of concrete was recently completed at Alki Point, near Seattle, Wn., at a cost of $23,800. This structure, shown in Fig. 2, gave great satisfaction to the Department and in the fall of 1913 the Board let a contract for a concrete light-tower at Point Wilson, to replace the old wooden structure erected in 1879. This point is at the entrance to Puget Sound and probably more shipping passes it every 24 hrs. than any other point located on this great inland waterway.

The contract was let to Portland, Ore., contractors for $9,000. Excavations were made in the sandy soil at the tip of the point 5′ in depth and a foundation of concrete mixed 1:7 was laid.

The building, shown in Fig. 3, is 28′ by 25′ 6″ in size, with walls 12″ thick. The tower is 47′ 6″ from ground to lantern, with an average thickness of 18″. The floor and walls are reinforced throughout with steel and all material are of the best, having to stand government inspection throughout. It is understood that the contractors lost considerable money on the job, not having had prior experience in building a structure of this kind.

The entire building, including the tower, is lined throughout with tiling 12″ x 12″ x 2″ to prevent dampness should any moisture seep through the walls. The tiling is covered with a thick coating of concrete and all outside and inside surfaces are faced with a 1:1 mixture.

The stairway is of concrete and consists of 40 steps. The ornate coping around the top of the tower, surmounted with brass rail, forms a balcony about the light. The building is covered with asbestos shingles.

The fog-signal consists of a compressed air siren, operated by two engines of 18 h.p. each. The concrete engine foundation is 14′ long, 7′ 6″ wide and 5′ deep. The fence consists of concrete posts with iron railing, being probably the first of its kind to be built by the Department on the Pacific Coast.

The tower on the old wooden beacon was not removed until some time after the new light was in commission; thus was presented the curious sight of two lighthouses on one point.

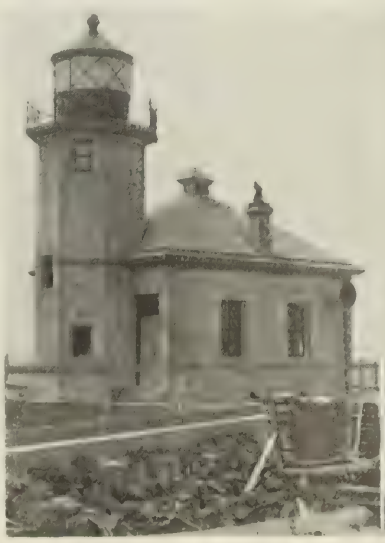

FIG. 2—ALKI POINT, WN., CONCRETE LIGHTHOUSE—FIRST CONCRETE LIGHTHOUSE IN 13TH DISTRICT

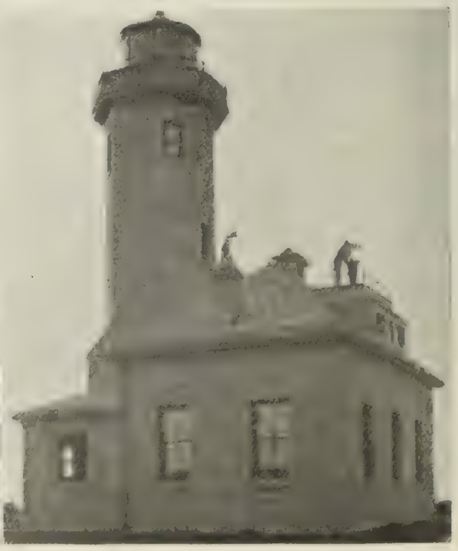

FIG. 3—CONCRETE LIGHTHOUSE AT POINT WILSON, WN.

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[1] Port Townsend, Wn.

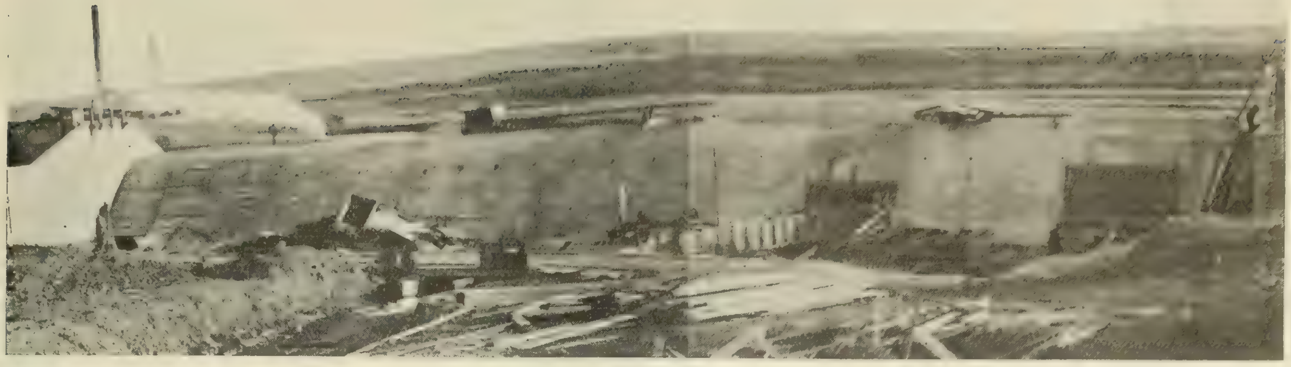

Fig. 1—General View of Reinforced Concrete Storage Dam at Swift Current, Sask., Canada

Reinforced Concrete Storage Dam at Swift Current, Sask., Canada

By J. B. Babcock[1]

A reinforced concrete dam of the Ambursen type has been constructed on Swift Current river in connection with the storage reservoir for the town of Swift Current, Sask. Previous to the completion of this reservoir, the town, now incorporated into a city, had been getting its water supply direct from the river; but owing to the cold winter of 1912-1913, and the lack of snow, the springs forming the source of this river became frozen, thereby completely cutting off the town from its water supply. The seriousness of this water famine, and the possibilities of its recurrence another year, led the Swift Current officials to arrange for the construction of a storage dam as soon as possible.

The Ambursen hollow reinforced concrete type of dam was selected as being best suited to a gravel and clay foundation, and because of the rapidity with which it could be constructed. Actual construction began Aug. 19, 1913, and ended with the official acceptance of the dam by the town on Dec. 24, 1913.

A general view of the completed dam is shown in Fig. 1. The quantities of materials involved in this work were 5,300 cu. yds. of gravel and clay excavation, 5,000 cu. yds. of earth embankment, 1,200 cu. yds. of plain concrete, 2,300 cu. yds. of reinforced concrete including 100 tons of reinforcing steel, 37 tons of steel sheet piling and 32,000 f. b. m. of wood sheet piling. The entire work was carried out in the extremely short period of 19 wks.

The general layout, shown in Figs. 2 and 3, consisted of a spillway 178′ 10″ long with concrete core walls and earth embankments at each end, the total length of dam and core walls being about 750′. Fig. 4 shows a typical section of the spillway. The concrete in the upstream and the downstream cut-offs is carried through the gravel and at least 6″ into hard clay. Lackawanna steel sheet piling is driven at the bottom of the upstream cut-off trench, and "Wakefield" wooden sheet piling consisting of three 2-in. x 10-in. planks bolted together is driven in the downstream cut-off, all piling projecting up at least 6″ into concrete, and extending 7′ 6″ into the blue clay. Buttresses are 14″ thick and spaced 12′ o. c. with temperature reinforcement around the doorways and near the bearing faces. Cut-offs are poured with 1:2½:5 concrete, buttresses, floor and hearth with 1:3:6 mixture, and all decks, aprons and runways with 1:2:4 mixture. Two 3-in. wrought iron pipes are placed in the apron of each bay to prevent the formation of a vacuum and the consequent tremor. Weep holes through the floor and a drain through the floor and a drain through the bucket are also left in each bay to relieve any upward pressure beneath the dam. Provision is made for the use of 3-ft. flashboards when desired, by the insertion of flashboard pins in the pipe sockets which are placed at 2′ intervals in the crest of the dam.

Fig. 5 shows a section through the intake. The intake is formed by the prolongation of the deck of the dam to the elevation of the abutments and the core wall. After exclusion of brush, etc., at the trash rack, water can be admitted into the screen chamber, which is 2′ 6″ x 2′ 6″, has eight 11¼-lb. channels emvalve on each of these pipes is controlled directly from the gate house, which is a small structure of steel and Hy-Rib[2] construction. The screen chamber, which is 2′ 6″ x 2′ 6″, has eight 11¼-lb. channels embedded in the concrete and these act as guides for the screens which are placed in 2-ft. sections in chamber. The outlet from the screen chamber is controlled by an 18-in. valve operated by bevel gears and crank in gate house. From this outlet the water is carried by 18-in. pipe to the pumping station.

The abutments are of the cantilever type and made of 1:2½:5 concrete. The concrete core walls are of plain concrete, 1:3:6 mixture, 2′ wide at the top, battered ¼″ to 1′ on each side, and carried 6″ into clay. Beneath these core walls wooden sheet piling is driven of the same type as under the downstream cut-off of the spillway, and extending about 7′ 6″ into blue clay. Earth embankments are made on each side of the core wall, width on top of embankment being 12′, with slopes of 2½ to 1 and 2 to 1 on upstream and downstream sides respectively.

Fig. 6 shows the progress of the work about 2 mos. after construction had started. The method of handling the river by a flume is clearly shown in this view. An upstream cofferdam of A-frame construction was built at a narrow point in the river, a short distance above the work, and a simple cofferdam of sheeting and toe-fill was built just below the dam. The flume through which the river was carried was built

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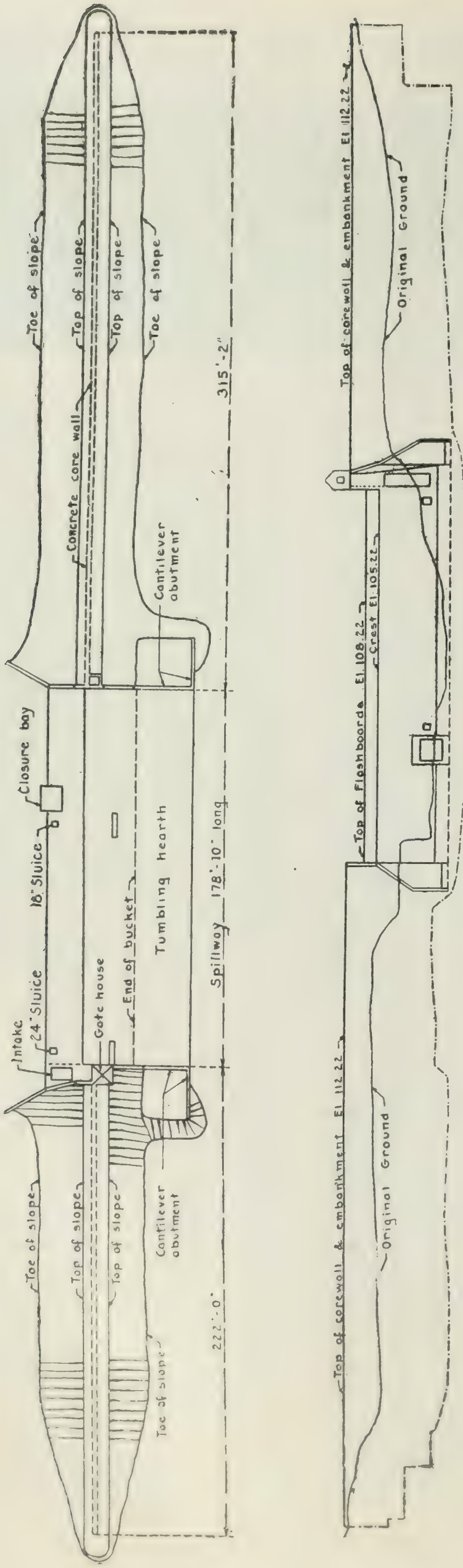
[1] Res. Engr., Ambursen Hydraulic Const. Co., Montreal, P. Q., Canada

[2] Trussed Concrete Steel Co., Youngstown,



FIGS. 2 AND 3—GENERAL LAYOUT AND ELEVATION OF REINFORCED CONCRETE STORAGE DAM AT SWIFT CURRENT, SASK., CANADA

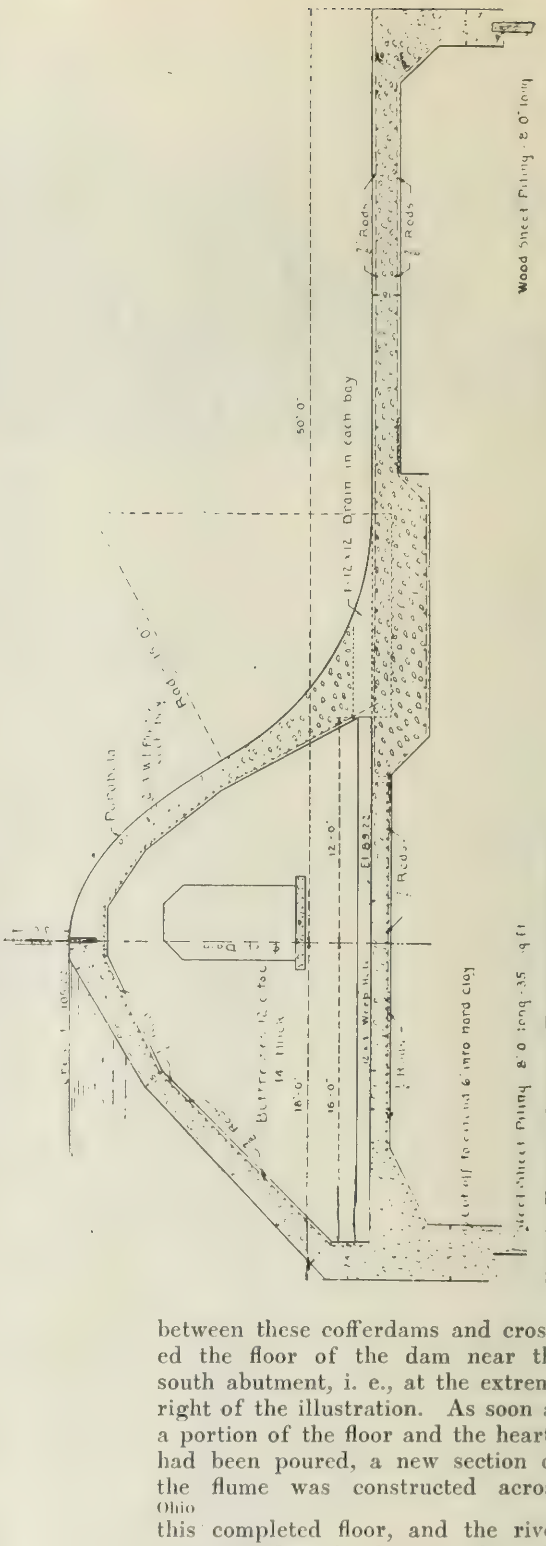

Wood Sheet Piling 8'0" long
Rods
50'-0"
Drain in each bay
El 89.22
12'-0"
16'-0"
Buttress 12' c to c 14" thick
Steel Sheet Piling 8'0" long 35 sq ft
Cut off to extend 6' into hard clay

FIG. 4—TYPICAL SECTION THROUGH SPILLWAY

between these cofferdams and crossed the floor of the dam near the south abutment, i. e., at the extreme right of the illustration. As soon as a portion of the floor and the hearth had been poured, a new section of the flume was constructed across this completed floor, and the river was carried at this location throughout the remainder of the work. The abandoned section of the flume was torn out to allow of the excavation for the remainder of the floor and the hearth.

Fig. 7 shows a panorama of the spillway and the abutments, looking upstream. This view, taken about five wks. later than that shown in Fig. 6, gives an idea of the various stages of construction appearing with this type of dam. At this date, Nov. 23, 1913, core walls and abut-

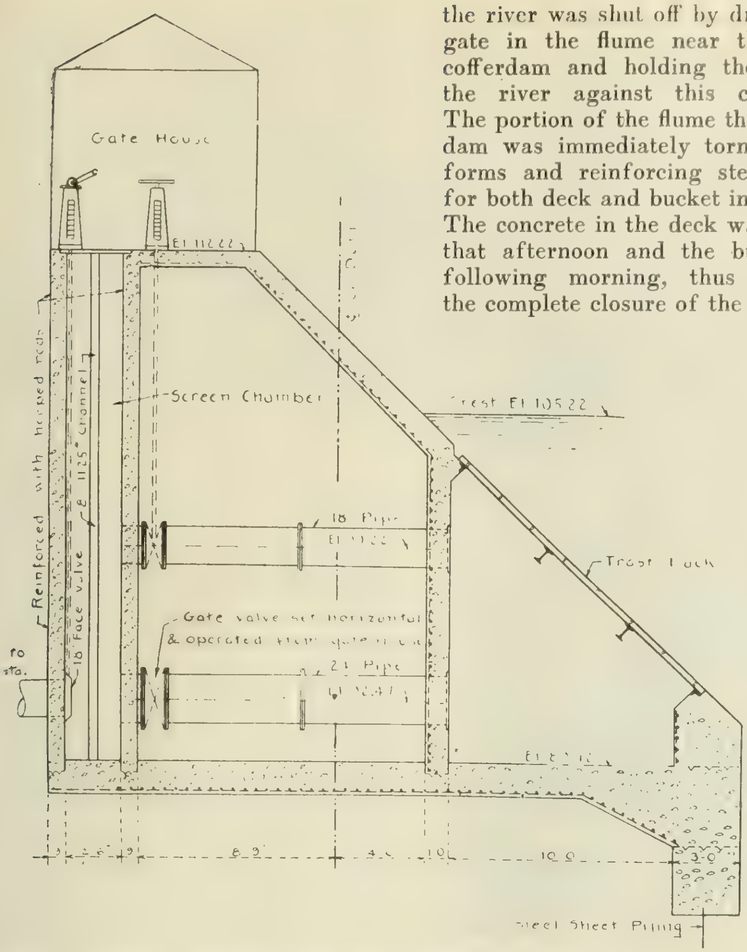


Fig. 5—Section Through Intake and Screen Chamber

ments were complete, the remaining work being merely pouring the reinforced slabs of the spillway and grading embankments at the north core wall.

The spillway was all poured by Dec. 12, with the exception of a portion of the deck and the bucket in the bay through which the flume was carried. The deck at this bay had been carried out in a flat slab over the flume and adjacent buttresses and extended 3′ upstream. Stop-log grooves and a groove to receive the final deck slab were left in these buttresses as well as two square openings in extended flat slab to pour final portion of deck. Dec. 22, the river was shut off by dropping a gate in the flume near the upper cofferdam and holding the rise of the river against this cofferdam. The portion of the flume through the dam was immediately torn out and forms and reinforcing steel placed for both deck and bucket in this bay. The concrete in the deck was poured that afternoon and the bucket the following morning, thus effecting the complete closure of the dam.

The dam was formally accepted Dec. 24, by the town engineer and members of the town council. At this time the 18-in. sluice gate was opened and a portion of the flow of the river allowed to pass downstream to the original town intake which was still in operation, and to the C. P. R. pumping station which supplied the railway's water tanks at the town.

PERSONNEL

The dam, intake, etc., were designed and constructed by the Ambursen Hydraulic Constr. Co. of Canada, Ltd., Montreal. The designing was done under the direction of W. F. Farley, and the work was carried out in the field by F. E. Cushman, supt. of const., and the writer as resident engr. G. R. Heckle, mgr. dir. of the company, was in charge of all branches of the work. Throughout the construction, the town of Swift Current was represented by Geo. D. Mackie, then town engr., now engr.-commr. for the city of Moose Jaw, Sask.

Care must be exercised and precautions taken to prevent large masses of forms from falling on floors, as the work must be so conducted as to avoid injury to the concrete.

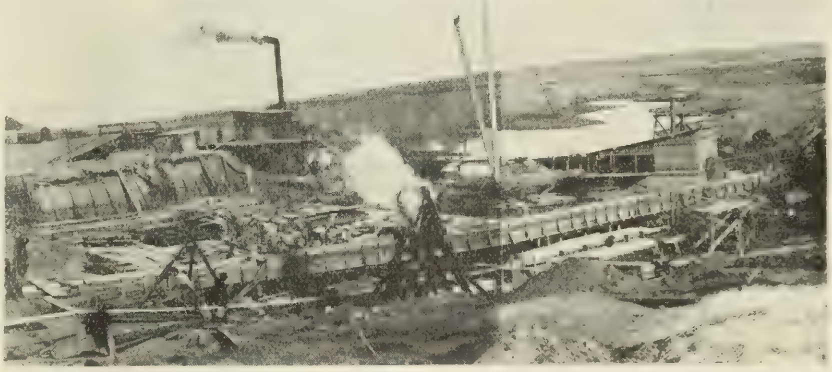


Fig. 6—General View Looking North, Storage Dam at Swift Current, Sask., Canada
The flow of the creek was handled by means of a small wooden flume

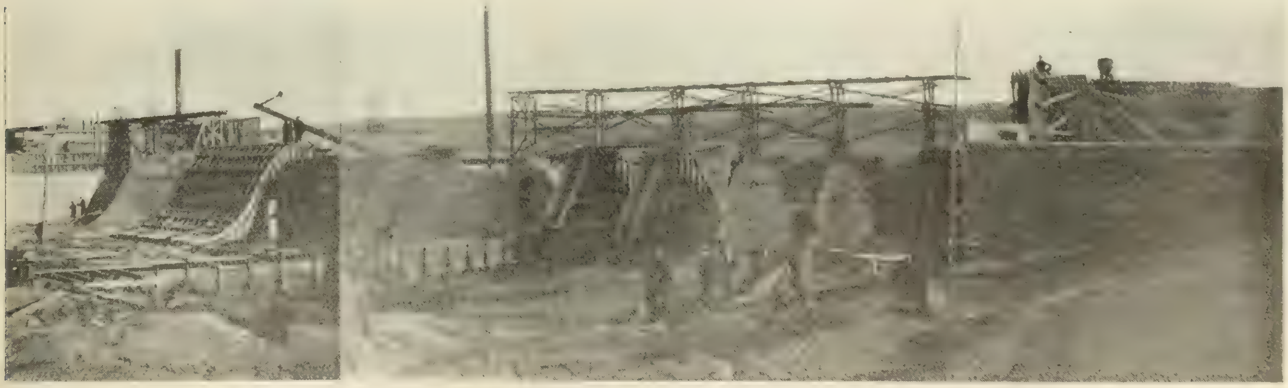


Fig. 7—General View Looking Upstream, Taken 5 Wks. Later Than That Shown in Fig. 6

Concrete Versus Stone Revetment, in the Kaw Valley Levee Work

By E. B. Murray[1]

The type of revetment agreed upon by the Kaw Valley drainage board in 1908 for the river side slopes of the dikes was of two types, one a stone or riprap revetment comprising one-man stone set vertically on edge and laid close together with a 4-in. covering of spalls over the entire surface, as shown in Fig. 1, and the other a concrete slab 4″ in depth and reinforced through the center by triangular mesh wire (No. 9) run through the whole length of the slab.

CONCRETE SLAB REVETMENT

The concrete slabs were constructed 8′ wide with a 3/8-in. seven-strand galvanized cable running throughout the length of the slab (see Fig. 7). At the bottom these cables were bent back into the slab a distance of 4′ and the loop left to project out so as to form an eye to which further extensions of the protection could be made from time to time.

The mixture for the slabs was 1:2:4. The slabs were poured directly from the top of the embankment by a portable mixer which emptied directly into the wooden chutes, as shown in Figs. 2, 3 and 4. After the chutes had been laid clear down the entire length of the slope, concrete was placed between the side boards to a depth of 2″. As the work progressed up the slope, sections of the chutes were set to one side.

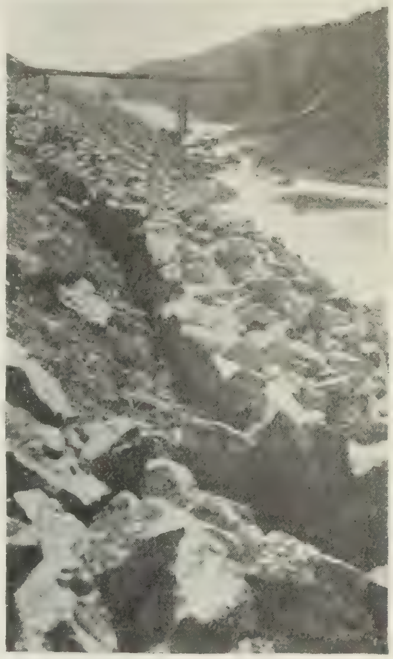


Fig. 1—Rock Revetment on Kaw Valley Levee Work Near Kansas City, Mo.

Rock laid perpendicular, with the smallest surface uppermost

When the 2-in. layer of concrete finally reached the top, the wire cables and the triangular mesh were laid, the chutes replaced and the entire operation repeated. Rough troweling was done with shovels and only every alternate slab poured, as shown in Fig. 4, thus giving each slab time to set before an adjoining slab was placed.

The sides of the slabs were necessarily rough and slightly irreglar,owing in some cases to the bulging of the forms , so that when the intermediate slabs were placed the bond between them was good and in a way they were keyed into those that had been previously poured. The slope was thoroughly wet before any concrete was placed in order to avoid the earth's absorbing any of the water of the concrete. Fig. 2 shows the position of stationary mixing plant where the top of the levee was too narrow for the plant to be moved from time to time. It also shows bundles of triangular mesh reinforcement and narrow-gauge track over which the dump-cars operated after having been filled at the mixer.

Figs. 3 and 4 show the mixing plant and the concreting of alternate slabs. Note in Fig. 3 the difference in the color of the slabs that have just been poured and the ones that were poured first. Fig. 4 shows how the first 2″ of concrete for the slab is poured and spread. It also shows how the chutes are handled, the position of the mixing plant, which is moved ahead with pinch-bars after the slab is poured, and the walking boards used by the men in going up and down the slope.

Fig. 5 shows the dump-cars in operation, dumping concrete into the chutes.

Fig. 6 shows the plant layout used to construct all of the revetment where the full width of the top of the levee could be utilized.

The concrete materials were hauled in wagons and deposited at con-

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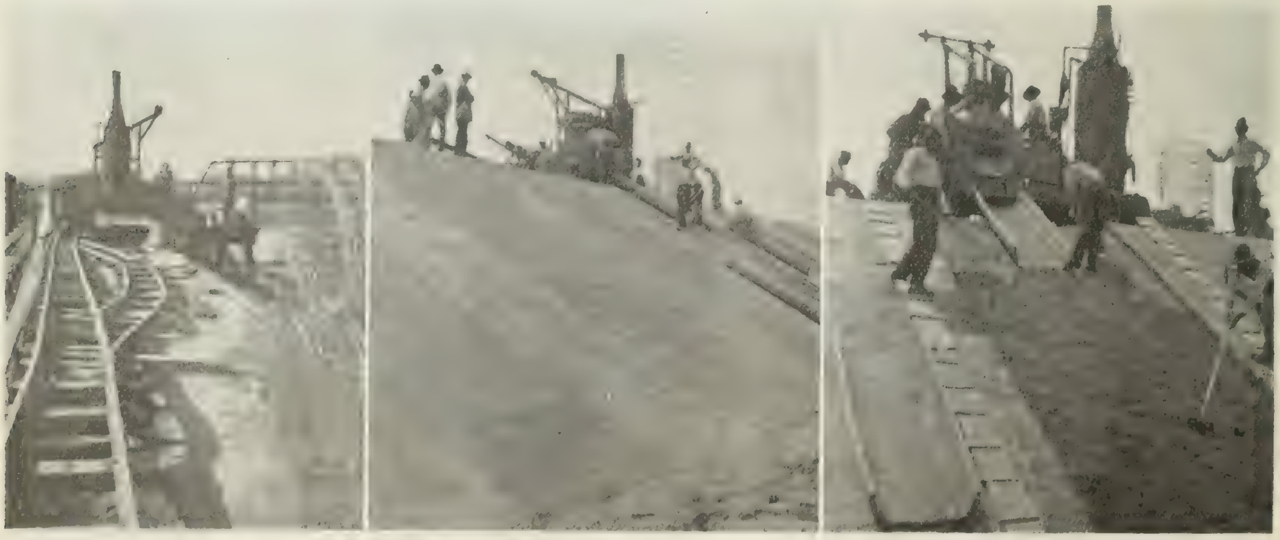
[1] E. B. Murray & Co., Cons. Engrs., Kansas City, Mo.



Figs. 2, 3 and 4—Placing Concrete Revetment on Kaw Valley Levee Work near Kansas City, Mo.

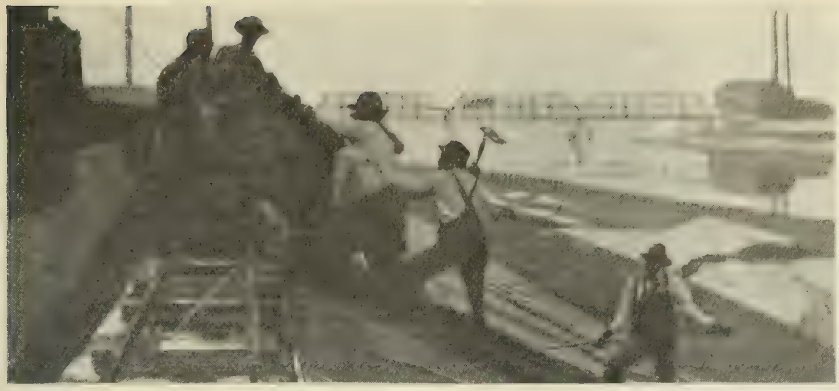


Fig. 5—Portable Cars Dumping Concrete into Chutes

venient points along the top of the levee and toward the rear. A ¾-in. pipe line furnished water for the boiler and the mixer.

The plant was moved up close to the river slope of the levee and as soon as a slab had been poured it was moved ahead on running boards by means of pinch-bars until it was in position to pour the next slab.

The crew usually employed was composed of two men to wheel sand, two for the chats, one for the cement, one engineer who also attended the mixer, one man to shift the running boards and six men to handle the chutes and spread the concrete.

CONCRETE BLOCK REVETMENT

A third type of revetment, which served as an auxiliary to the concrete slabs, consisted of concrete block 4″ x 24″ x 22½″, reinforced with the wire mesh above mentioned and also with 21¼-in. galvanized rods looped at each end so as to form an eye at opposite ends of the block, as shown in Figs. 7 and 8. These block were used at the foot of the embankment in order to prevent the river from cutting under the concrete revetment, as shown in Fig. 9. They were fastened together by ⅜-in. galvanized iron seven-strand cable, which was threaded through the eyes of the block and also through the eyes of the cable at the bottom of the slabs.

It will be readily seen that the concrete block revetment was substantially the same as a willow mattress, except that it had to be laid when the river was extremely low and could extend out to the water's edge only. The theory of this type of revetment was that when the river started cutting out under the toe of the revetment these blocks would follow the slope down, thus preventing any great amount of damage.

On different portions of the work, great difficulty was encountered through the slope's sliding and bulging out at the bottom, due to subaqueous springs that flowed over an underlying stratum of blue clay or rock, which pitched toward the river. Where this occurred, it was necessary to bring back the material that had slid and replace it in the slope or to cut the slope over again, bringing in new material and wasting that excess material which was at the foot of the slope. Several of these slides occurred where the riprap type of revetment had been placed, with the result that the revetment had to be taken out and the slides repaired at a great expense.

The cost of the original riprap per sq. yd. was $1.25, while the cost of replacing it after the slides had occurred was about $1.80. The concrete revetment cost 3 cts. more per sq. yd., or $1.28, but none of it had to be replaced after it was laid.

At two particularly bad places, one at each side of the river in the vicinity of the Kansas City Southern bridge, slides occurred repeatedly and every expedient was used at these points to get the levee to maintain the prescribed slope. In one instance holes were drilled down through the rock formation and heavy charges of dynamite exploded, the plan being to break up the shelf over which the water was running and force it to seek another channel.

Another method used was to drive a tight row of Wakefield sheet piling, using 3-in. x 12-in. timber from 16′ to 20′ long and cabling it back to dead men set in the ground by the levee. Neither of these methods accomplished the desired result, but after replacing the dirt that had slid for the fourth or fifth time and revetting the slope as rapidly as possible with the above mentioned concrete type of slab, no further trouble has been encountered.

It is the writer's opinion that these slabs form such a bond with each other as to hold back any tendency of the dirt to slide out of place, and

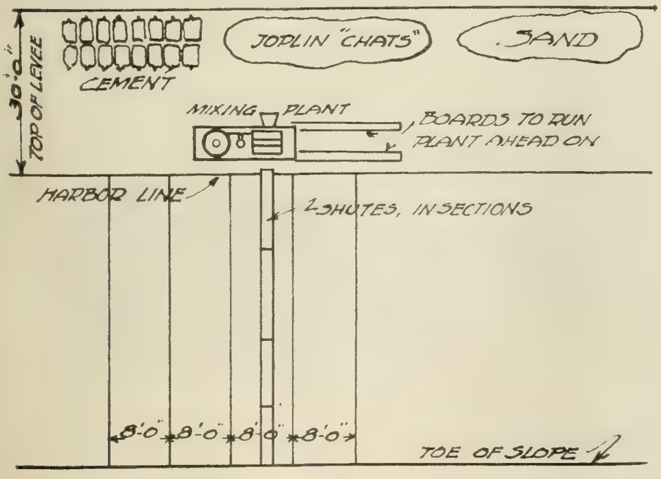


Fig. 6—Sketch Showing Concrete Plant Layout, Kaw Valley Levee Work

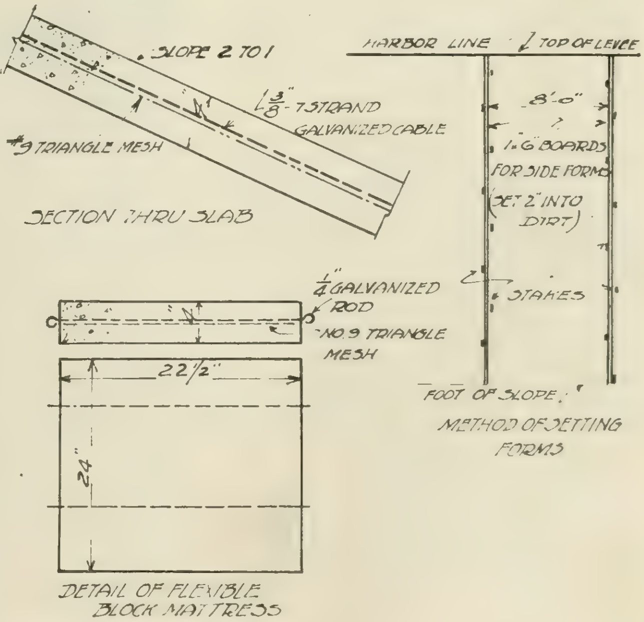
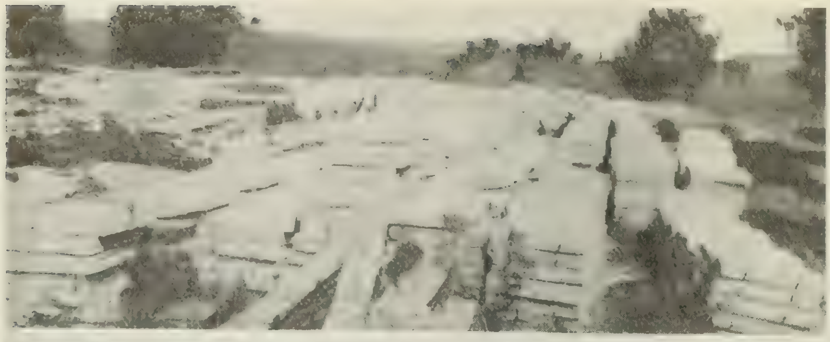


Fig. 7—Details of Concrete Block Used for Flexible Concrete Mattress



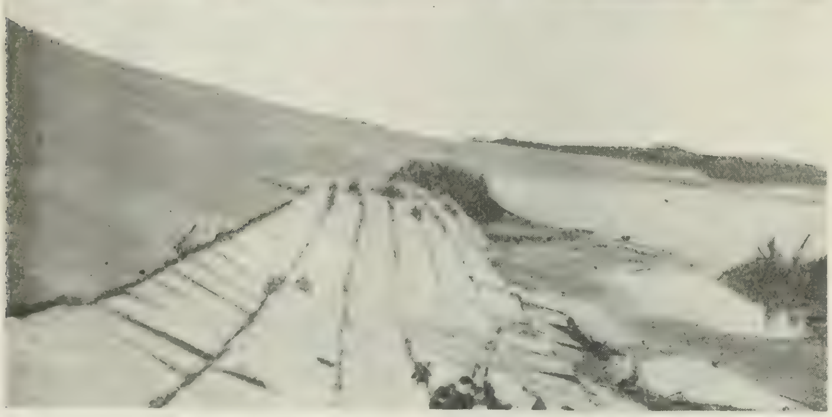


Fig. 8—Curing Concrete Block in "Block Yard"

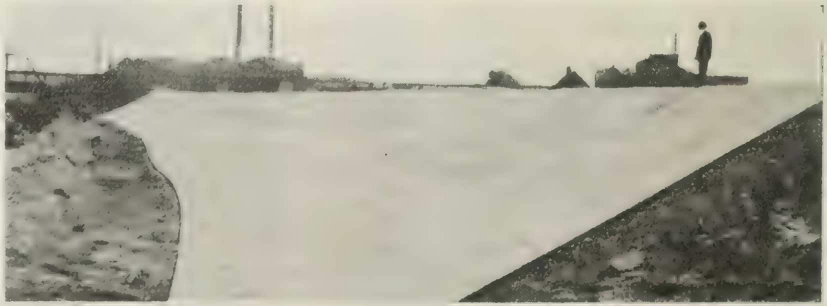
Fig. 9—A Stretch of Concrete Revetment

The concrete block are connected with ⅜-in. seven-strand galvanized cable threaded through the eyes in the block and in the bottoms of the slabs

also, if the material has a tendency to squeeze out under the bottom of the slab, the slab, in following this material down, either binds itself into those on each side or forms an arch over the hole. In either case it absolutely protects the bank from washing and in the event of the hole under the slab becoming so large that the slab should break, it is easily repaired by pouring another slab of concrete reinforced as the first was in this hole, first drilling holes in the old slab in which 8-in. dowels are placed in order to insure a firm bond between the two surfaces.

To the writer's mind, judging from the experience that he has had with this type of work, this method of protection is far superior to the riprap. It is more quickly placed, looks neater (see Fig. 10), offers less frictional resistance to the water, is more easily and cheaply repaired and wherever possible, especially if there is a small difference in the cost, it should be used in preference to riprap (see Fig. 11).

Inasmuch as 90% of this work was done by general contract it was impossible to get at the actual cost, but subsequent work which has been done by the Board of Directors has shown that this concrete can be placed for from $1.00 to $1.05 per sq. yd. This is taking into consideration the fact that the sand used is obtained from Stewart-Peck Sand Co.'s plants which are operated in the Kaw River and the stone was Joplin chats.



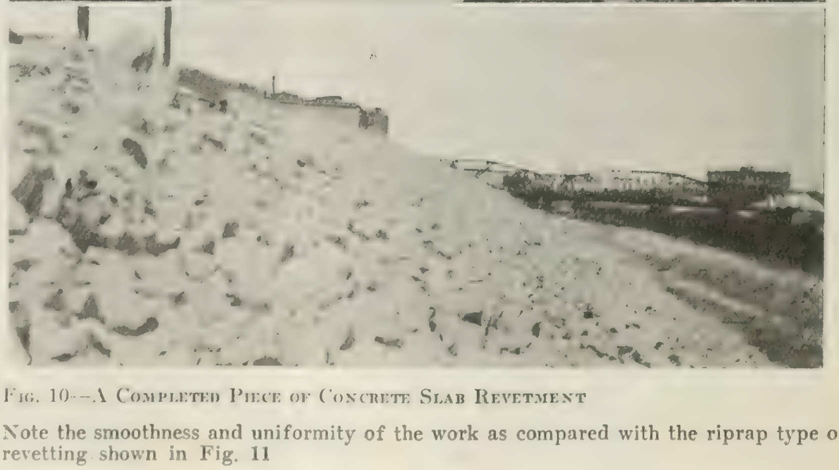


Fig. 10—A Completed Piece of Concrete Slab Revetment

Note the smoothness and uniformity of the work as compared with the riprap type of revetting shown in Fig. 11

Fig. 11—A Completed Piece of Riprap Work

Smooth Forms

The finish of forms for exposed concrete depends upon the degree of finish called for in the specifications. If the concrete is to show a smooth surface, the surface of the form in contact with it should be smooth. Joints should be made perfectly flush after they are built in place by planing off any unevenness or projections that occur or any openings at joints or corners. Knot-holes or other voids should be plugged flush with some stiff, plastic substance, such as fire clay mixed with plaster of paris, or sand.

Our old friend *Daily Consular and Trade Reports* has taken a new title. It comes now under the name of *Commerce Reports* and marks an advance in the work of the Bureau of Foreign and Domestic Commerce. The new paper is to be an up to date journal. Instead of taking four days in the making, as the old *Daily Consular and Trade Reports* did, the *Commerce Reports* will be turned out at the Government Printing Office within 10 hrs. with the latest word from all the markets of the world. Much interesting information will be available.

Exposed surfaces of freshly placed concrete should be shaded by boards or tarpaulins to protect them from rain, dust, wind and the hot rays of the sun.

Notes on Concrete Construction on the N. Y. State Barge Canal

By Geo. C. Mills[1]

The State of New York has brought nearly to completion the greatest engineering enterprise undertaken by any state. The Barge Canal system, with a main line 342 mi. in length from Albany to Buffalo, one branch from the Hudson to Lake Champlain, a second from Syracuse to Lake Ontario, and a third on the south to Cayuga and Seneca Lakes, comprises, with intervening lakes and rivers which have been canalized, a total of 790 mi. of navigable channel having standard dimensions.

The old Erie canal has witnessed many years' development in construction methods. Built with a water depth of 4′, which was increased within 50 yrs. to 7′, by wheelbarrows and teams, the channel is now deepened to 12′ after the removal of 125,000,000 cu. yds. of excavation by present-day machines, operated largely by power electrically transmitted. The contractor and his huge working tools are about to disappear, and the structural features which will serve as monumental records of the change from the old to the new are the monolithic masses of concrete. Every masonry structure on the Erie canal was of quarried stone; on the Barge Canal concrete is used throughout. About 3,000,000 cu. yds. of concrete have been placed.

Reinforced concrete has been used sparingly. The platform approaches on the bridge abutments, the footing connections of walls and the flooring of troughs are reinforced, as are also the power stations, 20′ x 30′ in plan and about 20′ high, built adjacent to the locks, which are to be lighted and operated by hydro-electric plants.

CONCRETE LOCKS

The main line of the canal across the state is served by 35 locks and the branch canals by 22. The length of the locks between gates is 340′, accommodating boats 311′ long. The width is 45′ and the water depth over sills is 14′, providing for future enlargement. The lifts vary from 6′ to 40′. The lock with a 40-ft. lift is at Little Falls on the Mohawk River. with the exception of those at the This is the greatest lift in the world Panama locks. At Lockport and at

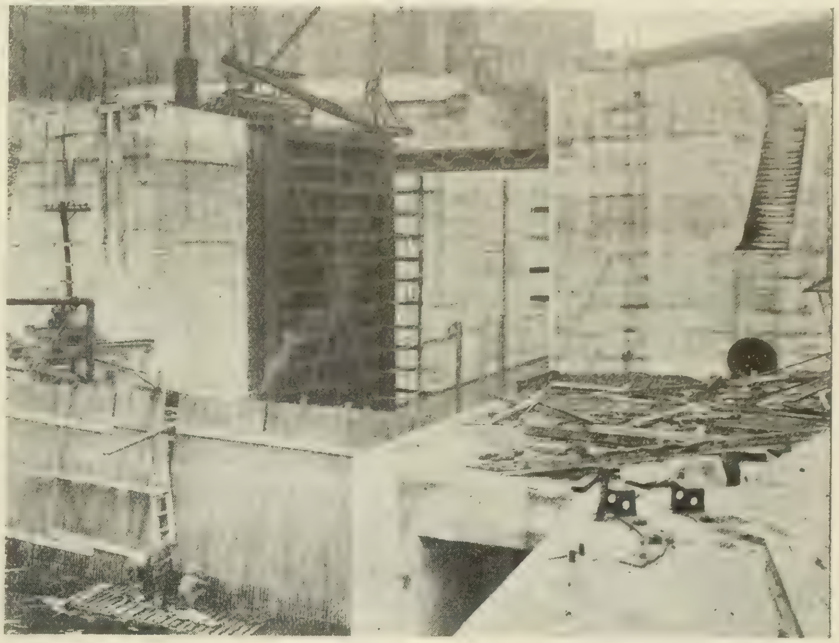


Fig. 1—Head of Lock at Lockport, N. Y., Looking East, N. Y. State Barge Canal

Seneca Falls are flights of two locks combined tandem with a total lift of 49′, as shown in Figs. 1 and 2. The side walls of the locks vary from 28′ to 60′ in height, reaching an extreme of 80′ in one section of the Little Falls lock. The width of the walls at the top is from 5′ to 7′ and at the bottom from 13′ to 34′.

The lock design, following well tried principles, is noteworthy because of ingenuity in meeting local conditions and of skill in handling materials during construction. A multiplicity of problems, comparatively simple yet vital to ultimate success, is an important distinction between this and the Panama Canal, with fewer but vastly more complicated obstacles to overcome.

CONCRETE TROUGHS

The concrete troughs of the Barge Canal are of special interest because of the use of concrete under original plans designed to meet unusual conditions. In the eastern portion of the state, the stream flow is generally parallel with the course followed by the canal, and much of the new channel is formed by river canalization. The streams in the western third of the state run north, and the problem has been met of constructing channel crossings over three broad valley depressions. The smaller Erie canal was carried across on embankments with side slopes of the

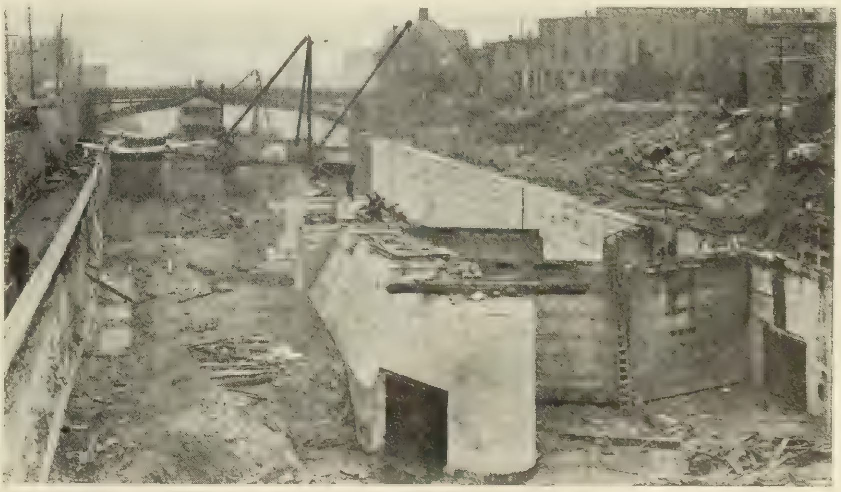


Fig. 2—Foot of Lock at Lockport, N. Y., N. Y. State Barge Canal

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[1] Civ. Engr., Rochester, N. Y.

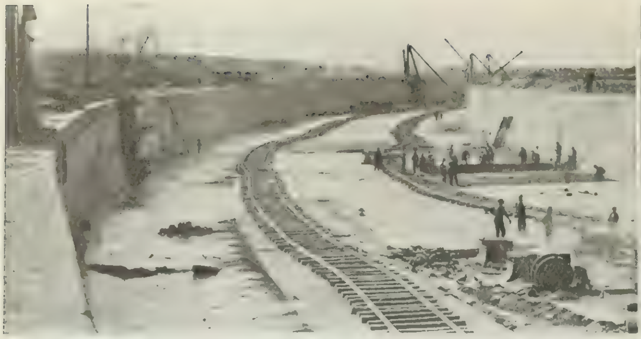

Fig. 3—Irondequoit Trough Looking West from East End, N. Y. State Barge Canal

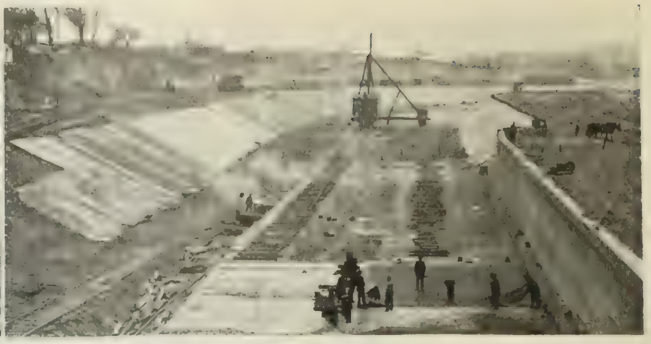

Fig. 4—N. Y. Barge Canal Trough Looking West; Part of the Irondequoit Valley Crossing

prism protected with planking. The greater weight and water pressure of the new channel required a different method.

The longest concrete trough is over Irondequoit Creek, 8 mi. east of Rochester; the second in length is at Holley, near the eastern border of Orleans Co., and is 104′ wide and 2,200′ long, and the third is at Eagle Harbor in the same county, 600′ long and 94′ wide. The last two have been completed and in operation during two seasons of navigation and neither leakage nor settlement has appeared. The water depth provided in all troughs is 14′.

Figs. 3 and 4 show general views of the Irondequoit trough and lining.

DESIGN OF THE IRONDEQUOIT TROUGH

The Irondequoit Trough is 3,800′ long and 96′ wide, upon an embankment reaching 80′ in height over the greater part of its length. Owing to excessive curvature in the alignment of the old canal, the new embankment was built upon a direct course. The material is a fine sand brought by train and settled in place by water-jets. The embankment was completed in the fall of 1910. Construction of the trough began in Dec., 1910, and was completed in May, 1911.

From the end of the trough eastward, the new earth channel developed weakness and the sides and the bottom for a length of 1,900′ were protected with concrete lining. An additional trough, 900′ long, was also built, extending from the end of the lining over a culvert. Thus the canal for a length of 6,600′ passes through a channel constructed of concrete.

The trough walls and the side slopes of the lining were erected in sections 30′ long, jointed at the ends and without reinforcement except at the floor connections. The floor was then placed, the same method being used in building the floor for both the trough and the lining.

The floor is 22′ 6″ thick, composed of a bottom course 12″ thick laid in 30-ft. squares, reinforced as shown in Figs. 5, 6 and 7; upon this is laid tar-felt waterproofing covered with 6″ of sand filling, and a top course of 4″ of concrete in squares of 10′, as shown in Fig. 7. The reinforcement consists of ⅛-in. deformed bars 3′ long, spaced 6″ c. to c., and staggered.

Fig. 8 shows a typical detail of the joints in the walls of the trough.

There are approximately 50,000 cu. yds. of concrete in the 3,800-ft. trough, 12,000 cu. yds. in the 900-ft. trough, and 13,000 cu. yds. in the 1,900-ft. lining, making a total of 75,000 cu. yds.

CONSTRUCTION METHODS

The concrete plant was established at the east end of the 3,800-ft. trough, convenient for delivery of gravel from a nearby pit located on high ground. The gravel was hauled to a bin by a dinkey train on a trestle about 60′ high. From the bin the material was run by gravity into the crusher, and thence by belt conveyors was carried to two bins, one for sand and the other for crushed stone. At a lower elevation than the bins, three Koehring mixers,[2] each having 1¼ cu. yds. capacity, were installed to be operated separately or together.

From the mixers, chutes emptied into buckets on flat cars drawn by dinkey engine with two or three cars per train. Upon reaching the forms, the buckets were handled by Dobbie derricks.[3] After the walls were erected, the flooring was placed, the same general methods being followed. In addition to the gravel bin at the crusher, a considerable amount of gravel was banked below and supplied to the crusher by a derrick whenever delivery from the pit was delayed. With this precaution the concrete reached the site without interruption between batches.

The trough walls were erected with Blaw steel forms[4] which were housed in and coke fires maintained, keeping the temperature at about 40° F. during zero weather. Through these precautions, operations were not delayed even in the coldest weather and satisfactory results in the completed structures were secured. As

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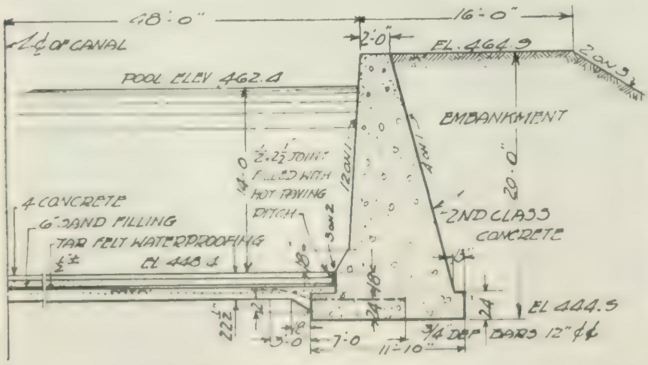
[2] Koehring Mach. Co., Milwaukee

[3] Dobbie Fdy. & Mach. Co., Niagara Falls, N. Y.

[4] Blaw Steel Constr. Co., Pittsburgh



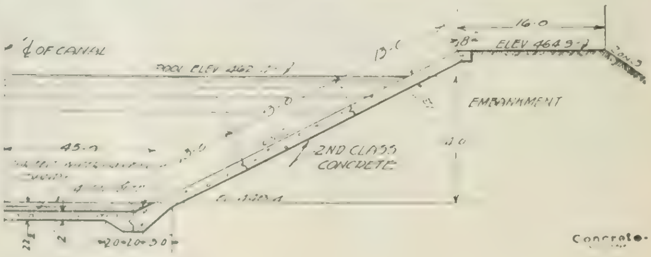


Fig. 5—Typical Section Showing Concrete Trough, Irondequoit Creek Embankment

Fig. 6—Typical Section Showing Concrete Lining, N. Y. State Barge Canal

a portion of the new channel follows the line of the Erie, concrete was laid in the winter, in order not to interfere with navigation.

From 800 cu. yds. to 900 cu. yds. of concrete were laid per da., the concrete being mixed in the proportion of 1 part Portland cement, 2½ parts sand and 5 parts broken stone. These proportions have been practically the standard on all structures on the canal.

The contract price was $7.00 per cu. yd.

The 3,800-ft. section has been in commission, beginning with the season of 1911, and has developed no structural weakness. Seepage has not appeared. The trough has settled 0.15′ without evidence of strain. The shorter trough of 900′ and the section protected with lining went into commission a year later, with equally favorable results.

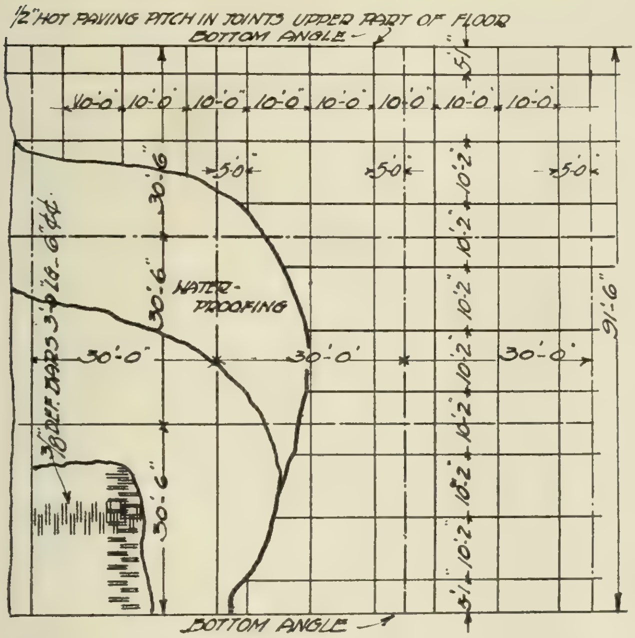
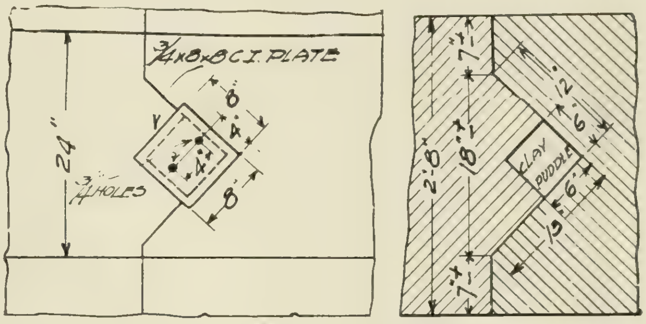


FIG. 7—PLAN SHOWING ARRANGEMENT OF SQUARES OF REINFORCING IN FLOOR SYSTEM



PLAN AT TOP OF WALL SECTION AT EL 462.9

FIG. 8—DETAIL OF JOINTS IN TROUGH WALLS

BREAK IN THE IRONDEQUOIT TROUGH

A large break occurred Sept. 2, 1912, over the Irondequoit Creek culvert, after nearly two seasons of navigation had elapsed. At this point the trough was built upon the old embankment of the Erie canal, which settled under the greatly increased load, opening joints in the structure. The earthwork was torn away by the rush of water, and in a few minutes 700′ of trough had fallen; a partial view of this is shown in Fig. 9.

Temporary repairs were rushed, a timber flume 22′ wide was erected and navigation reopened at end of 6 wks. The flume has been continued in operation, pending adoption of plans for permanent reconstruction. This subject has been carefully considered and it is believed that the plans when adopted will provide for reconstruction of the embankment settled in place by water-jet, a period for settlement by continued use of the concrete flume and rebuilding the concrete trough.

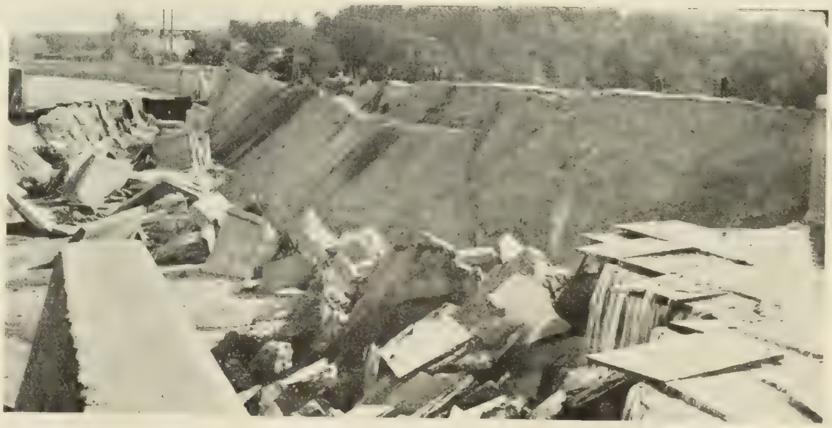


FIG. 9—VIEW SHOWING THE IRONDEQUOIT CREEK BRIDGE 6 MI. EAST OF ROCHESTER, LOOKING EAST, SEPT. 2, 1912

GUARD GATES

Near both ends of each trough in Orleans Co., and of the 6,600-ft. section across Irondequoit valley, guardgates are situated to shut off the flow in case of leakage or a break. These gates, while minimizing damage, cannot prevent disastrous results to adjoining property and to navigation, should structural failure occur.

MISCELLANEOUS

The combined length of channel depending for security upon troughs and lining, 9,400′. Strength, imperviousness and durability are essential qualities in the concrete, while from the nature of the structures absolute uniformity in materials and workmanship is as imperative as in the construction of a dam. Several seasons of navigation have afforded tests satisfastory to the engineers responsible for results, and creditable to the contractors whose methods in planning their work and manipulating materials accomplished the results with speed and certainty.

Describing a new method of handling concrete in the Franklin tunnel, the Los Angeles *Times* says:

> A contract was closed yesterday with the agent of an hydraulic cement placer, to be used in lining the Franklin tunnel, which will save the department about $8,000 on the job. Instead of hauling the mixed cement into the tunnel in cars and shoveling it behind the forms as heretofore, this machine works outside the tunnel and shoots the cement behind the forms through a pipe. The rapidity of the process, which was inspected in operation up north by an engineer of the water department, is so rapid as compared with the old way that the saving is about one-half on the job.

A continuous mixer may be tested by measuring out a batch of concrete in the desired proportions and running it through the machine to see whether or not it feeds correctly. If not mixed properly it should be run through again or mixed by hand. Several tests should be made each day to see that the cement delivered is constant in amount.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

The Regulation of Concrete Block Manufacture and Use

Discussed By S. W. Stratton,[1] W. M. Kinney[2] and James C. Keller[3]

"We should like to see some discussion of regulations governing the manufacture and use of concrete block and concrete stone which might point the way for municipal building code requirements consistent with the requirements of other building materials, and at the same time consistent in the sense of some uniformity of regulation as among various cities. The wide range of city building code regulations of strength and absorptive qualities is very disconcerting and indicates indecision, disagreement and lack of knowledge of what really should be expected of the material. First: Why should a compressive strength of 1,000 lbs. per sq. in. of gross area (1,500 lbs. net area) of block be required? Why not 1,200 lbs.? Would a requirement of 1,200 lbs. afford ample protection? Is not the requirement of 1,500 lbs. inconsistent when common brick used in many cases in similar work as concrete block, crush at from 700 lbs. to 900 lbs.? Is it not wrong that a building code permits the loading of block to only 8 tons per sq. ft., while requiring a compressive strength in net area of 72 tons? Is not a factor of safety of 9 unnecessarily conservative in view of the fact that the loading of a reinforced concrete column is permitted up to 46 tons? Second: Is it right, in view of comparison with other materials, that a building code requires that concrete block shall not show more than 5% absorption? Third: Is not it possible that the real solution of the difficulty is in a sliding scale of requirements depending upon the nature of the work and the wall height? A semi-wet process block (a tamped block) is a good unit for some construction and is economical. Should it be made to come under the same regulations as a cast stone made to compete with high-priced natural stone in more expensive work? Should not the regulations govern the uses of the materials of certain varying strength and absorptive values and leave it to the manufacturer to decide what kind of business he wants to get? One manufacturer might choose to make concrete stone to resist compression up to 3,000 lbs. or 4,000 lbs. and have an absorption as low as 3%. His product could be designated as No. 1 or "A" and so marked in manufacture, and its use be permitted under loading conditions based upon its real loading value. Another manufacturer might make a product to test 1,000 lbs. net area in compression and at 5% for absorption. His product would be marked "B." Still another manufacturer produces concrete block in class "C" for use only in light, two-story construction where the walls would be hollow or otherwise insulated and waterproof. Why should not block for this purpose be passed for use on all work where common red brick would be acceptable, with a compressive strength of 700 lbs. and absorption up to 10%, which would be an improvement upon the density of a large amount of common brick?"

By Mr. Stratton

The need of more uniformity in the building law requirements governing various types of building materials has long been recognized. Most of these differences arise from a lack of definite knowledge regarding the properties of different types of building materials and from a desire to utilize local materials as much as possible.

The allowable working compressive stresses for various types of masonry construction depend on the strength of the constituent materials, i. e., the binder and the filler. It must be recognized that the strengths of individual brick or concrete blocks differ considerably from the strength of the masonry in which these materials are employed. The character of the binding material greatly influences the resulting strength of the masonry. Further, in choosing the compressive stress requirements of concrete block or brick it should be remembered that the ultimate strength of these materials is considerably in excess of the stress at which these materials take a permanent set and begin to fail. Therefore, when it is recognized that masonry composed of concrete block generally develops less strength than concrete block alone and further since the ultimate strength is considerably in excess of the point at which the material begins to fail a factor of safety of 9 is not unnecessarily conservative.

With regard to the limits specified for absorption of concrete block two factors must be borne in mind.

First, the durability or the resistance of concrete block to the action of frost and the elements, and second, the appearance of the surface following a storm or exposure to moisture. The damp appearance which some plain concrete block present for some time after exposure to water has prejudiced many people unnecessarily against their use; brick escape this prejudice because of their color and the character of their surfaces.

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[1] Dir. of the Bur. of Standards, Washington, D. C.

[2] Engr. in Charge Insp. and Inf. Bur., Universal Portland Cement Co., Chicago

[3] Gibraltar Stone Co., Cleveland

If the surface of concrete block were to be given character by means of exposed selected aggregates or the block covered with a stucco of pleasing appearance, the prejudice arising from the damp appearance of plain concrete block following their exposure to moisture would disappear. Stucco of Portland cement and sand in which the amount of water absorbed is as high as 10% has successfully withstood the action of frost and the elements.

Building law requirements should be amplified so as to permit the use of all materials capable of resisting the action of frost and the elements, and of sufficient strength to carry safely the load required for various types of buildings. This could be accomplished, in the case of concrete block, by establishing different compressive strength and absorption requirements for various classes of concrete block.

By Mr. Kinney

The question is: Shall the manufacturer of one-piece, tamped block, made from a rather dry mixture using fine aggregate, be encouraged in his efforts to compete in price with the poorest and cheapest building materials marketed in his locality, or shall he be educated to the superior possibility of well made concrete block?

If the former attitude is to be taken, then pressure may be brought to bear upon building departments to lower the established standard of building codes, so that block of the poorest quality may be admitted. This can be accomplished by removing restrictions, lowering standards, or establishing a so-called "sliding scale." In doing any of these things the concrete block is invited to injure the entire cement industry by exposing to the layman in his business building or residence the lamentable spectacle of concrete which is porous, weak and otherwise unsatisfactory. Naturally all concrete construction would be jeopardized thereby.

On the other hand, if concrete block are manufactured according to recognized standards insisted upon for concrete construction in other forms, the manufacturer of concrete block will have little cause to worry about price competition with the poorest and cheapest classes of other building materials. Well made concrete block have a right to recognition as building units of a high order. Concrete block may be successfully faced with granite, marble, mica, feldspar and similar materials so that their appearance will rival or excel that of granite itself. There was a time when the common imitative appearance of concrete block faces made their specification in buildings of the better class difficult or impossible to secure. Concrete block are no longer regarded as an imitation of any other building material. Present practice tends towards the production of surfaces distinctly characteristic of concrete. Wherever concrete has been recognized as a building material governed by laws peculiar to itself and possessing merits peculiarly its own, it has not failed to attain a foremost place in building construction. To suggest that concrete block cannot be made to attain similar superior quality and like recognition as a building unit, is an admission of ignorance of present-day progress. Therefore, concrete block makers should recognize the laws of concrete if they are to profit from the merits of concrete. Consequently concrete block should be made of a mixture employing properly proportioned aggregates of various sizes up to ½ the thinnest section of the block to be manufactured. This mixture should contain sufficient water to secure thorough hardening and full strength of the cement. The mass should be well compacted, and the block thoroughly cured. When concrete block are so made, their manufacturers will have no quarrel with the building code of their city, for the simple reason that the product will exceed in compressive strength any test that has been specified by the building code of any American city; and the absorption in a properly proportioned concrete block made in this manner will be negligible.

By Mr. Keller

In determining the compressive strength of concrete building block the tendency on the part of those who frame city building codes has been to err on the side of ultra-conservatism. This is due to several causes, among which the following are the most prominent:

First, lack of knowledge on the part of some block-makers as to the proper method of making block of uniform strength *at any standard.* Second, lack of proper information on what constitutes good concrete building units. Third, the influence of interests which might lose part of their markets should concrete units be placed upon an equal footing with their own products.

Taking up the first reason we are forced to admit that it is based upon good grounds. There are a great many engaged in making concrete block who are pushing the business as a "job" and who imagine that anything that holds together constitutes a block.

An industry in the course of development is very largely judged by the poorest product rather than by the best, consequently an entire industry is made to suffer for the shortcomings of the few, and no matter how well or how scientifically block can be and are made, yet it is to protect the consumer that the standard of safety is set at the highest possible point.

Second, those responsible for the preparation of codes are generally governed by past associations, consequently the average American architect, especially east of the Mississippi and north of the Ohio river, having had experience in stone, brick and iron, permits the use of concrete but grudgingly, basing his opposition upon the assumption that the use of concrete for building purposes is as yet in an experimental stage.

Third, the influence of brick and stone interests is shown in the attitude of those cited in the previous paragraph.

To sum up: The compressive strength of block should be determined by the use to which they are put. Thus a compressive strength of 700 lbs. per sq. in. of net area is more than sufficient for single-family two-story houses of frame construction when such block are used for foundations. For two-family houses of frame construction 800 lbs. is ample, while for two-story buildings either of block or of brick a 12-in. block with a compressive strength of 1,200 lbs. will more than meet all safety requirements.

The requirement of 5% minimum absorption for concrete building block is discrimination pure and simple and is traceable to outside influence.

It goes without saying that the proper system to follow is one which requires block of varying strength for different kinds of construction. If in structural steel we estimate the carrying load, and conform beams to it, naturally in foundation and wall construction with concrete block the same rule should be followed. It may be well to say, however, that until the manufacturers have become responsible it is not advisable to allow such latitude, as the results might be such as to forbid entirely the use of block. When the concrete business has once been established as an industry the inconsistencies in our building codes will disappear.

The Use of Blast Furnace Slag as an Aggregate in Concrete □ □

Discussed By S. G. Reynolds,[1] W. A. Aiken,[2] F. Tschudy[3] and Miles T. Bitting[4]

1. "Do you consider that a good, clean, blast furnace slag makes a concrete that is as good as, or better than one in which broken stone or gravel is used?

2. "What is the present attitude of the building codes in the large cities in regard to the use of crushed slag as an aggregate in concrete for fireproofing structural steel and in reinforced concrete construction?

3. "Is it necessary to insist upon chemical analysis being made at a commercial testing laboratory when using crushed slag as an aggregate in important concrete work?

4. "Should crushed slag be aerated when used as an aggregate in concrete? If so, how long?

5. "How should concrete be proportioned when using crushed slag?"

By Mr. Reynolds

(1) Briefly we answer in the affirmative, basing our opinion upon years of practical experience and careful study of concrete construction in which slag, stone and gravel have been used respectively as coarse aggregate and also upon extensive field and laboratory tests which we have carried on in connection with our business of mining, crushing, screening and distributing of slag, not alone for concrete, but also for street and highway construction, roofing and railroad ballast. We would add that, so far as we are aware, every scientific or commercial test ever made in this or foreign countries to determine the comparative compressive strength of slag and other concretes has resulted in favor of slag concrete.

(2) We do not find on file building codes for 1914, but we believe those of the cities of Chicago, Cleveland, Toledo, Pittsburgh and probably others we cannot at present recall either mention slag as permissible or use the words "or other acceptable material," with a view to permitting the use of slag when available.

(3) It is entirely unnecessary, for the reason that the chemical analysis of slag can always be obtained from the blast furnace producing it or through the distributors of slag. We quote average analysis of the basic slag produced in the Birmingham district:

Silica	33.045
Lime	46,341
Iron and aluminum	15.645
Magnesia	.745
Sulphur	1.12

(4) We offer for sale no concrete slag that is not air-cooled and thoroughly seasoned in the bank before digging with steam shovels. We would advise against the use of slag for concrete purposes that has not been seasoned for at least 6 mos. The slag which we dig has been in the bank anywhere from 1 yr. to 21 yrs.

(5) The same as when using crushed stone. The average mix for foundation work or retaining walls is 1:3:6. For columns, floors, roofs or other work above ground a richer mix may be used. For the last mentioned purposes, the comparatively light weight of slag (approximately 2,000 lbs. per cu. yd.) makes it exceptionally desirable.

By Mr. Aiken

(1) Results as given in my paper before the Am. Soc. for Test. Mat., June, 1914, at Atlantic City, N. J., show that a good quality of furnace slag compares, in my opinion, very favorably with the ordinary run of other materials used as aggregate in concrete.

(2) I have always understood that many of the large cities of the Central West permit the use of the proper quality of crushed slag as aggregate, and I have reason to believe that it is about to be introduced in this city on a par with all other materials.

(3) It is absolutely necessary to have chemical analysis to determine the quality of slag to be used as aggregate in important concrete work, as the character of this material varies very widely and not every slag is good, by any means.

(4) Slag to be afterward crushed up as aggregate for concrete purposes should be bank cured, the longer the better, but for at least 6 mos. to 1 yr.

(5) No differently from other material.

By Mr. Tschudy

(1) I consider, and know from my experience, that a good, clean, blast furnace slag makes a concrete as good as that made of broken stone, or gravel, provided such concrete is made in proper proportions properly placed, and does not have to stand direct water pressure. In the use of good, clean, blast furnace slag for concrete work, either plain or reinforced, much depends upon the proper kind of slag, the correct proportions making up the aggregate, and more so than that, upon the correct handling in placing the concrete.

In my experience I have worked blast furnace slag in sizes varying from material passing the 3-in. ring, down to the granulated slag passing a ½-in. ring, and in all the years of my experience along this line I have never regretted the use of the correct slag for its particular application. It is distinctly understood that the slag used shall not have a porosity greater than that of building brick. The broken material should, as much as possible, represent broken stone.

On the plant here, which I built 4 yrs. ago, there were 84,000 cu. yds. of concrete placed, and not one single pound of broken stone or gravel was used. Our proportions of Portland cement to ordinary slag are 1:9. In other words, we have used Portland cement in our construction solely for the purpose of finshed work exposed to the weather, while unfinished work also exposed to the weather has been made with slag cement. In the past 4 yrs. we had occasion in various instances to break into concrete made of blast furnace slag 4 yrs. ago, and in several cases we have found it well-nigh impossible to penetrate concrete work built with blast furnace slag and slag cement.

In all of my experience with concrete work built from blast furnace slag, consisting of foundations for all kinds of buildings, coke ovens, heating furnaces, rolling mill foundations, blast furnace foundations, and the like, I know of but one failure in the concrete work and this was due entirely to heat. In this case, a mat on which coke ovens were placed with the heating surface too close to the concrete, the mat parted, showing cracks as wide as 3″. These cracks were, as stated, due to excessive heat, but more due to frictional conditions brought about by the expansion of the brick work resting on this concrete mat.

In no case that I can remember have I experienced any other trouble with blast furnace slag concrete than that of penetration of water under high pressure through walls built of blast furnace slag and slag cement. On the other hand, I know of hundreds of jobs subject to similar conditions built of broken stone or gravel and Portland cement, which would not resist penetration of water under like pressure. In fact, in construction work, wherever I can obtain blast furnace slag, I prefer it to the use of broken stone and particularly to the use of gravel.

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[1] Sec., Birmingham Slag Co., Birmingham, Ala.

[2] Philadelphia

[3] Coke Oven Engr., Tennessee Coal, Iron & Railroad Co., By-Product Coke Plant Division, Fairfield, Ala.

[4] Sec., Emanuel & Co., Chautauqua, Pa.

(2) Not being a municipal engineer nor a civil engineer of note, I do not care to know about the attitude of the building codes in large cities in regard to the use of crushed slag. I am not an engineer whose position is subject to political pull, or to catering to political henchmen. I base my constructions on experience irrespective of any code made up by politicians.

(3) It is not necessary to insist upon chemical analysis of crushed slag used for concrete work. I intentionally leave out the "important." In (1), I have answered the point referred to by "important" as I feel that any construction which has to serve a certain commercial purpose is important enough to consider the material used for its construction. There can not be a foundation more important than that of a big building, be it for factory or municipal purposes or a foundation for a heavy armor-plate mill or a rolling mill and in all work of such nature I have let my experience be my guide in the selection of slag, rather than the chemical analysis of a chemist who may make in his analysis as many errors as I could make in my judgment based on experience, or even more.

(4) This question is ambiguous. To my knowledge blast furnace slag is disintegrated by aeration. If it is crushed thereafter, it has been aerated previously.

(5) With the term "crushed" included in the question, an answer is rather difficult to make. The proper proportions of concrete aggregate, that is, the relation of cement, sand and slag, depend entirely and solely on the kind of work to be built, its purpose, the weight it has to carry and the size of slag which is used and I do not think that there is any difference in the proportions used with an aggregate of blast furnace slag from that used with broken stone, providing the work is intended for the same purposes, subject to the same condition and placed with the same care.

By Mr. Bitting

(1) The comparative strength tests made by disinterested persons for different cement companies prove conclusively that it from 8% to 10% stronger than stone concrete.

(2) Most cities allow the use of blast furnace slag for concrete work. The City of Philadelphia has made very successful experiments on this material and does not hesitate to use slag in reinforced concrete construction and fireproofing work.

(3) No. Such concerns as the Bethlehem Steel Co., South Bethlehem, Pa., Atlas Portland Cement Co., and Vulcanite Portland Cement Co., which are equipped with the very best testing laboratories, do not make a chemical analysis of our slag. They buy large quantities from time to time.

(4) Yes, for at least 6 mos.

(5) This depends entirely upon the purpose which the concrete is to serve. If it is for a wall, say not more than 18″ thick, a mixture of 1:3:6 will do. If for heavy machinery foundation a mixture of 1:2:4 will be more satisfactory.

Editorial Discussion

A booklet first issued in 1911 by the Carnegie Steel Co., Pittsburgh, presents the results of a series of tests of blast furnace slag, in various forms, for use as an aggregate in making concrete. Conclusions of the tests in which mixture containing river sands and gravels were regarded as standard so that in general bank slags tested higher than either gravel or limestone and all slag aggregates compared favorably with the gravel standard.

The notice that prompted this investigation, which was begun in July, 1908, was the knowledge that almost any hard substance that has strength and will not readily disintegrate, would make a good aggregate in concrete. The list of materials ordinarily used for this purpose is large. ranging from broken granite and other rocks to broken brick and ashes.

A careful study of "Furnace Slags in Concrete," mention of which has been made above, will show that the aggregate performs a very important function and that the strength of the concrete depends very largely on the shape, character and strength of the aggregate.

It is a mistake to leave the waterproofing work entirely to the contractor by not specifying the exact materials and the methods to be employed, as is quite often done. The specifications must be clear in the matter of indicating what is absolutely required, without any alternative, and what is named as indicating in general the character of the product, and in which alternative materials, methods or results, will be allowed.

Use of "Pudding Stones"

Discussed By Wm. M. Kinney

"To what extent may so-called "pudding stones," that is, stones larger than the regulation 3-4-in. to 2-in. size, be used in mass concrete?"

By Mr. Kinney

Sabin in *Cement and Concrete* says: "Stones thus embedded should be perfectly sound and should not lie nearer one to another than 6 ins." Taylor and Thompson in *A Treatise on Concrete* say: " The distance between the stones varies in different specifications from 3″ to 18″. * * * The quantity of rubble is usually expressed as a percentage of the total mass of the finished concrete. The percentage may vary from 20% to 64%." The proportion is governed by the size of stones, the consistency of the mixture and the size and the nature of the work.

There is a general rule of concrete construction that limits the size of coarse aggregate to particles that do not exceed in greatest dimension one-half the thickness of the wall or other member of the construction in which they are employed.

After conforming to this limitation the "pudding stones" must be properly proportioned with sufficient graded materials of smaller sizes thoroughly to fill and slightly to exceed the voids existing between the "pudding stones" themselves.

One other question arises in connection with the use of "pudding stones" or "nigger heads" in concrete, and that is the compressive strength of the stones themselves. As is well known, the strength of concrete cannot exceed the strength of the aggregates used.

Therefore, "pudding stones" may be employed as aggregate upon the same basis as any other aggregates, and the strength of the concrete will not be impaired unless the "pudding stones" themselves are lacking in strength.

Proportioning by sieve analysis is the most exact and effective method of studying the character of the aggregate and for calculating the effect of various mixtures. In this method the available materials, excluding the cement, are separated into various sizes by means of a series of screens.

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[1] Engr. in Chg., Inf. Bur., Universal Portland Cement Co., Chicago

Heating Concrete Aggregates

DISCUSSED BY WM. M. KINNEY,[1] LEONARD C. WASON,[2] JULIUS RUOFF,[3] R. L. RICKMAN[4] AND H. B. KRIER[5]

"What is the highest temperature to which concrete materials can be heated without injuring the concrete? Most specifications stipulate that the materials should be a little warmer than would be comfortable to hold the material in the hand, for too much heat would cause the cement to set too quickly."

BY MR. KINNEY

Too high a temperature will cause many sands to turn red, while certain varieties of stone and gravel if over-heated are likely to soften or crack. A temperature not exceeding 150° F. will generally prove most satisfactory. It should be remembered, however, that one of the objects in heating aggregates is to insure that the concrete when deposited will have a temperature of approximately 100° F., which will assist in the development of internal heat and promote early hardening, provided adequate protection is afforded for such length of time as is necessary to accomplish this object. Heating by steam has an advantage over heating by the use of the ordinary types of sand heaters. When these are used there is a possibility of damaging some of the material next to the heater from the extreme heat often necessary to thaw out sand or gravel at the top of a pile, unless it is occasionally turned to insure uniform heating.

Sand and stone may safely be heated by piling them directly on pipe coils supplied with steam, or by covering with tarpaulins and applying steam directly to the materials. Short pieces of iron pipe connected with the boiler by lengths of hose are often stuck into piles of aggregates and steam allowed to escape through the materials. With a good steam pressure this system is quite effective and has the advantage of avoiding rehandling of materials, which is often necessary when using other methods.

BY MR. WASON

I am afraid that I cannot answer your question as to the highest temperature, as we have never used thermometers on our work. As it is not usual for us to heat all the aggregates, I cannot say what the average would be. Where the work is of considerable size and it is possible, we usually put steam coils on the ground, connected with the boiler, and pile the sand and sometimes stone on these. Then a steam pipe with flexible connection is frequently used to heat the upper surface locally. Sometimes aggregate is used so hot that it would burn the hand, probably nearly as hot as the steam itself. It is usual to heat the sand in this way, because it is the most likely to lump up and is the easiest to heat. Stone is kept covered with canvas to prevent its being filled with ice and snow, and as a rule it is not so much heated. The sand is relied upon to remove all frost from the surface of the stone and to warm up the water and the cement. It is common to see a batch of concrete being transported into place which is steaming, and a batch sometimes feels warm to the hand, which means that it is at least 100″ F., but just what the temperature is we have never attempted to determine. We have never had any trouble from cement flashing, due to the heat of the aggregate, and think that it cools quickly after being placed, although we take precautions so that it does not cool below the freezing point.

BY MR. RUOFF

In my experience in concrete work, the forcing of setting concrete too much by heat will take a great part of the strength from the concrete. The best result in strength of concrete will be given by a concrete with normal setting condition, which has been kept wet or damp for several days. The quick absorption of water from concrete in the beginning of setting by heat will make this concrete weak. It will be advisable to heat the stone and sand in freezing weather, and to use warm water for mixing the frozen material and protect the concrete with salt, hay or straw, if possible, for a few days.

BY MR. RICKMAN

In my opinion, the conditions surrounding each job should govern the method used. In some cases it might be more convenient to heat the aggregates, in others, the water. If the aggregates are to be heated, I would prefer that it be done by injecting live steam into the aggregates by means of a perforated pipe. This, I think, insures a more nearly uniform temperature than do salamanders or other methods of dry heating. Besides, in dry heating, some of the aggregates which come in contact with the heating surface of the heating apparatus become excessively hot and dry, and in case of very coarse aggregates being used, the coarser particles might retain a temperature different from that of the smaller. They would also lose a large part of the natural moisture which they may have contained, and this excessive dryness, together with the heat, would tend to prevent perfect hydration of the cement, thus creating a poor bond.

If occasion should arise that required me to place concrete in freezing weather, I should heat the aggregates by steam injection and use as little water as possible to make a slightly quaking mass when rammed. I would also mix each batch at least 25% longer and when placed would do more ramming than if a wetter mix were being used. I have never seen concrete damaged by freezing except where an excess of water was used and insufficient ramming done. I believe that it possible to use too much water as well as too little, and contractors are given to using an excess of water, more on account of the reduction of labor incident to ramming than for any other reason.

Therefore, I would say: Heat your aggregate by steam injection, be careful as to the amount of water used, mix each batch at least 25% longer than usual and when placed, ram thoroughly, and I think that Nature will take care of the results satisfactorily.

BY MR. KRIER

I always let atmospheric conditions control the heating of the aggregate.

I like to get the water around the hundred mark, and if the sand is dry and not frozen, I do not heat it unless it is exceeding cold, say below 20° F. I like to get the stone somewhere around 130° to 150°. I find that if all the materials are heated too hot the cement sets too fast, thereby reducing the strength of the concrete.

In one of the experiments I tried last winter, I heated the water to 100°, sand 50°, stone 130°. Mixed sand and cement dry, then added stone and water, filled a small mold 1′ x 2′ x 10″, covered it with a piece of heavy canvas, set it out in a cold place and left it there all night and the next day. I found that it had become hard on top and had not frozen. I then left it there two weeks (the last week it was covered with snow). I found that it had set better than what I had in a box corresponding to this one kept in a place where the temperature had been around 70°. In this second box the materials were not heated.

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[1] Engr. in Charge, Inf. and Insp. Bur., Universal Portland Cement Co., Chicago

[2] Pres. and Mgr., Aberthaw Constr. Co., Boston

[3] Ruoff Constr. Co., Philadelphia

[4] Contr., Eau Claire, Wis.

[5] Contr., Philadelphia

I then tried an experiment, heating all material to 150°. I found at the end of two weeks that the concrete was very flaky, also the block was full of surface cracks.

During these experiments we had some of the coldest weather of the season; the first night the temperature got to the zero mark, which is cold for Philadelphia.

Concrete Mail Box Post Near Dallas, Tex.

Concrete Posts for Mail Boxes

The accompanying illustration shows a novel but thoroughly practical use of concrete. It is a post supporting a mail box on a rural free delivery route near Dallas, Tex. Wooden posts are always subject to rapid decay at the ground level, where alternate wetting and drying take place, and to avoid the necessity of renewals and repairs the concrete post was made. It is quite ornamental in design, and at once conveys the impression that the owner takes pride in the appearance of his premises.

Concrete posts do not warp, decay or burn. When used for fencing they keep in better alignment than wooden posts.

Correspondence: A Department in Which the *Reader* Becomes the *Writer* □

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow." □ □ □

Concreting in Cold Weather □ □

A Letter From H. O. McMillan[1]

For tile and joist floor construction we build what is known as open forms, enclose the framework of the building with tarpaulins and heat with salamanders. As soon as the concrete is poured and has sufficiently set, we place hay on the floor to protect it from frost. The hot air passes through the openings in the tile to the concrete joist and slab above. We have had good success in pouring concrete when the thermometer has registered as cold as 10° F.

In solid slab work if the weather is too severe, we leave several openings in the form, allowing heat from salamanders to escape up through the slab. We cover the top of the slab with tarpaulin, raised 4″ or 6″ from the upper side. In this manner we protect the concrete from all danger from frost on the outside.

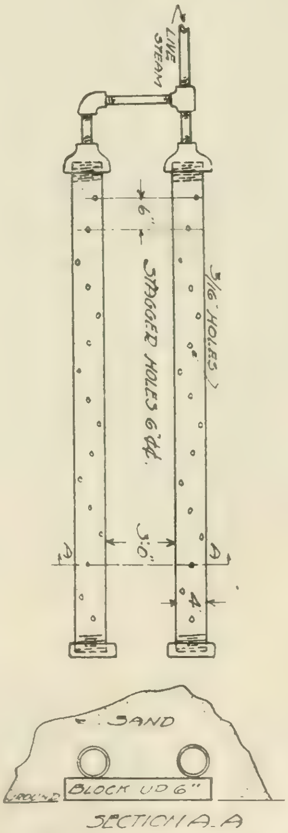
In addition to the above, and this is a matter of great importance, we heat our water and our sand. We heat our water by running exhaust steam from the mixer into a barrel of water, or set up a special boiler and run the live steam into the barrel. We heat the sand by a battery of two or more pipes, into which we run live steam, as shown in the accompanying illustration. The sand is dumped over these pipes and soon becomes heated to a high degree. We also heat the forms, iron and tile several hours before pouring the concrete. This takes the frost out of the iron and tile, and facilitates in keeping the aggregate mass from chilling. We also wet the forms, reinforcement and tile with hot water, just before pouring the concrete.

Following the above instructions one will have no more difficulty in pouring concrete in cold weather than he will when ideal conditions exist.

Flat Slabs in 1900 □

A Letter From B. W. Adams[1]

In your issue for June, 1914, I note an article by Wm. M. Bailey, entitled, "Flat Slab Floors in 1900," p. 290. Having had occasion to look into the early history of this class of construction, I found that the Bridgewater Reservoir referred to by Mr. Bailey has reinforcement as illustrated in the enclosed sketch. The working plans for this reservoir show strips of metal from column to column as two-way beam construction, these strips being marked "lintels" or "beams," with a set of sheets in the bottom of the slab throughout.



Sketch Showing Arrangement of Steam Pipes for Heating Sand

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[1] Supt. of Constr., Frank G. McMillan, Contr., Minneapolis

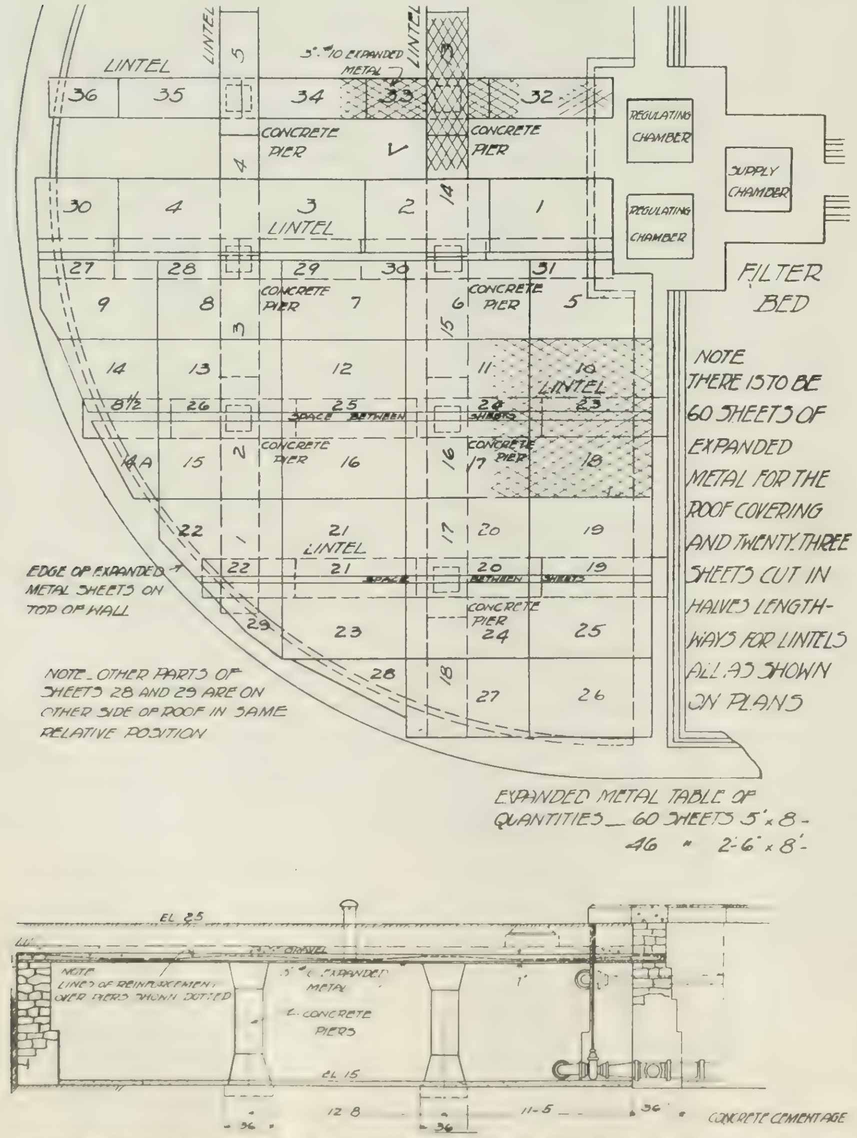
[1] Minneapolis

It would appear to the ordinary engineer that this is a beam construction with beams buried in a slab of uniform thickness. The position and the spread of the sheets as shown on the drawings would not produce the circumferential cantilever action which predominates in the commercially successful flat slab of today.

About the same time that this was put up, another reservoir was built at Elizabethport, originally with several columns to carry the dead weight of the roof. Within six mos. ofter its completion, about 30 columns were found necessary to hold the slab up. Also in a warehouse of similar design in the Bridgewater Reservoir, columns 16′ o. c. were surmounted by an 11-in. slab. The working load provided for was to be 400 lbs. per ft. or 52 tons per panel. A panel collapsed under 25 tons and the floor is now supported by alternate brick piers and concrete posts, having a spacing of 8′ instead of 16′ o. c.

Evidently there was something wanting in the performance of early concrete floors, flat in form, and the commercially successful flat slab construction which could with commercial economy carry loads for long spans is a construction originated at a later date.

I have also noted an alleged flat slab construction which Mr. Mensch claims, in *Proceedings* Natl. Assn. Cement Users (Am. Concrete Inst.), to have used in the Proctor & Gamble building at Armourdale, Kans. On investigating this, it developed that the building had no concrete floors but did have concrete foundations some feet in thickness on which columns were supported about 10′ o. c. This would hardly fulfill the modern idea of what is understood by a flat slab floor although Mr. Mensch would absorb the credit for its introduction by building a footing and failing to construct the upper portion of the building of concrete, using timber, which was probably more expensive than modern flat slab in the real floors of the building.


LINTEL
LINTEL
5″-10 EXPANDED METAL
LINTEL
CONCRETE PIER
CONCRETE PIER
REGULATING CHAMBER
SUPPLY CHAMBER
REGULATING CHAMBER
LINTEL
CONCRETE PIER
CONCRETE PIER
FILTER BED
LINTEL
SPACE BETWEEN SHEETS
CONCRETE PIER
CONCRETE PIER
LINTEL
SPACE BETWEEN SHEETS
CONCRETE PIER
NOTE
THERE IS TO BE 60 SHEETS OF EXPANDED METAL FOR THE ROOF COVERING AND TWENTY THREE SHEETS CUT IN HALVES LENGTHWAYS FOR LINTELS ALL AS SHOWN ON PLANS
EDGE OF EXPANDED METAL SHEETS ON TOP OF WALL
NOTE_OTHER PARTS OF SHEETS 28 AND 29 ARE ON OTHER SIDE OF ROOF IN SAME RELATIVE POSITION
EXPANDED METAL TABLE OF QUANTITIES _ 60 SHEETS 5′ x 8 -
46 " 2-6″ x 8′-
EL 25
GRAVEL
NOTE
LINES OF REINFORCEMENT OVER PIERS SHOWN DOTTED
5″ EXPANDED METAL
CONCRETE PIERS
EL 15
12 8
11-5
36
36
36
CONCRETE CEMENT AGE

Sketch Showing Design of a Reservoir for the State Farm at Bridgewater, Mass.

Possibilities of the 80-lb. Package for Cement

A Letter from Morris Metcalf[1] in Reply to an Editorial Inquiry

By Mr. Metcalf

While I still believe that the smaller package would be a good thing for all concerned, our experiments to date have not been entirely satisfactory.

So far as actual breakage in transit is concerned the smaller paper bags showed only a slight improvement over the present standard, and, in fact, the conclusions to be drawn support a theory we have had for some time that a large part of the breakage of paper shipments is caused by rough handling in transit, and would happen to the small package as quickly as to the large. In other words, it is not dependent upon the size or the weight of the package, but rather upon chance, the contributing factors being the condition of the railroad equipment, rough switching and handling, method of loading, etc.

In conducting these experiments on the 80-lb. package we unfortunately encountered an obstacle that had considerable influence in persuading us to discontinue them. The eagerness with which certain dealers accepted the 80-lb. package, and their desire for more, led to the conclusion that these fifth-bbl. packages were sold to the consumer as the standard quarter-bbl. package, and if used by him as such would, of course, result to the detriment of the concrete.

While these bags had the weight plainly printed thereon, it is probable that many customers do not know what a bag of cement ought to weigh, and unless it was explained to them they would almost be justified in assuming that they were getting the standard package. At any rate we are not making any further shipments in the small bags, and it was our thought that unless these first experiments plainly proved the hypotheses upon which the argument for the small package was based, we would not carry them further because there can be no question about the extreme difficulties that would be encountered in finally effecting the change in standard.

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[1] Formerly Asst. to Pres., Universal Portland Cement Co., Chicago

Organizations

American Concrete Institute, Charles L. Fish, Secretary, Harrison Building, Philadelphia, Pa.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. P. Beck, Sec., 208 S. LaSalle St., Chicago.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Two Buildings for 1916 Chicago Cement Show

Because of the remarkable increase in the demand for space at the last two Cement Shows, the Cement Products Exhibition Co. has found it necessary to secure the First Infantry Armory in addition to the Coliseum and the Annex for the 1916 Show. It was evident when all of the space in both the Coliseum and the Annex was assigned at the drawing Feb. 12, 1915, that something must be done in order to accommodate all the manufacturers who wish to exhibit. To the 100 exhibitors who applied for space in time to participate in the drawing all of the space available in the Coliseum and the Annex was assigned. This meant that 40 manufacturers who exhibited at the eighth Show, as well as the 70 other applicants who could not be accommodated with space, would have been unable to exhibit had not more space been provided, and this fact led to the rental of the First Infantry Armory, which offers 68 additional spaces—almost enough to accommodate all of the applicants for space at the eighth Show.

The rental of the Armory, however, necessitated a change in the dates set for the ninth Show. Under the new arrangement, following the practice of the automobile Show, the ninth Cement Show will open at 2 p. m., Saturday, Feb. 12, 1916, and will close at 11 p. m. Saturday, Feb. 19. It is believed that providing two Saturday afternoons will enable the Chicago architects, engineers, contractors and builders to attend the Show without serious interference with their regular business. Ample time has been provided for the installation and the removal of exhibits, both at the Coliseum and at the Armory.

Pan-American Road Congress

A Pan-American Road Congress will be held at the Panama-Pacific International Exposition under the joint auspices of the American Roadbuilders' Assn. and of the American Highway Assn.

The tentative date selected is that of the week of Sept. 6 next. The plans for the Congress will be handled by an Executive committee of five. This committee is made up of Gov. Charles W. Gates, of Vt., Chairman; W. W. Crosby, former State Highway Engineer of Md., and E. L. Powers, Editor of *Good Roads,* representing the American Road Builders' Assn., and James H. MacDonald, former State Highway Commissioner of Conn., and J. E. Pennybacker, Chief, Division of Economics, U. S. Office of Pub. Roads, representing the American Highway Assn. At the meeting held in Montpelier, Vt., Mar. 18, Gov. Gates was elected the fifth member, and Chairman of the committee. In order to facilitate its work, the committee has apportioned special work among four sub-committees as follows: Finance, Jas. H. MacDonald; Program, W. W. Crosby; Publicity, E. L. Powers, and Arrangements, J. E. Pennybacker. These sub-committees will start upon their work at once.

It is expected that this meeting will bring together not only official representatives from every state in the Union, but also from the Canadian provinces and many of the South American countries. Official invitations will soon be issued to the governors of the several states to appoint delegates.

The members of the committee have been working since the last of 1914 in making preparations for this meeting, and great interest has been shown in the work by those identified with highway improvement. The coöperation of other Good Roads organizations, the railroads and others is promised, with the result that it is expected that the meeting will mark a mile-stone in the propaganda for Good Roads.

The organizations under the auspices of which the joint Congress will be held are known as the two leading Good Roads associations of the U. S. Both associations, for the last few years, have held successful Congresses independently, but this year it was felt, in view of the Panama-Pacific Exposition, that it would best serve the interests of all Good Roads advocates concerned to hold a joint Congress during the Exposition. The selection of Gov. Gates as the fifth member is felt to be peculiarly fortunate, not only on account of his high official position as the chief executive of the state of Vt., and his ability and fairness, but because of the fact that he, for 10 years, or more, was the State Highway Commissioner of Vt., and it was due to his record in this office that he was elected governor by one of the largest majorities ever given a governor in that state. This election to the governorship is one of the highest tributes ever paid to a road builder, and so far as known, is the first instance on record of such recognition. The executive officers of the American Road Builders' Assn. are as follows: Pres., George W. Tillson, Cons. Engr. to the Pres. of the Borough of Brooklyn, N. Y. C.; First Vice-Pres., A. W. Dean, Chf. Engr., Mass. Highway Comm.; Second Vice-Pres., Austin B. Fletcher, State Highway Engr. of Cal.; Third Vice-Pres., S. Percy Hooker, State Supt. of Highways of N. H.; Secy., E. L. Powers, Editor *Good Roads;* Treas., W. W. Crosby, Former State Highway Engr. of Md.

The executive officers of the American Highway Assn. are as follows: Pres., Fairfax Harrison, Pres. Southern Railway Co.; Vice-Pres., Logan Waller Page, Director, U. S. Office of Pub. Roads; Chairman, Board of Directors, James S. Harlan, Chairman, Interstate Commerce Comm.; Chairman, Executive Committee, Leonard Tufts; Treas., John Burke, Treas. of the U. S.

A New Engineering Medal

Leonard C. Wason, president of the Aberthaw Construction Co., Boston, and president of the Am. Concrete Inst., who offered a new prize to be awarded annually by the Institute to the author of the best paper submitted to the Institute within the year, restricts the competition to members, and the papers must be original in every respect and not previously published elsewhere. All papers submitted to the Institute for publication in the annual volume are eligible to this competition, but the Board has the privilege of withholding the medal in any year in which no papers of sufficient merit to warrant its award are presented.

Mid-West Convention and Show Successes

The convention and show of the Mid-West Cement Users' Assn. were successes, with good attendance; and the convention was unusual in view of the fact that every scheduled speaker, as announced in the program published last month, was on hand and made his address.

The officers elected for the coming year are as follows: G. F. Lillie, Fremont, Nebr., president; Frank Whipperman, Omaha, Nebr., secretary and treasurer; C. J. Tracy, Loup City, Nebr., vice-president. Directors to serve three years: H. R. Park, Bruning, Nebr.; W. B. Farris, Albion, Nebr.; Geo. P. Dieckmann, Mason City, Ia. Directors to serve two years: John L. Zeidler, St. Joseph, Mo.; Frank Leeder, Sioux City, Ia.; A. P. Young, Nebraska City, Nebr. Directors for one year: N. J. Peterson, Omaha, Nebr.; Wm. Acheson, Superior, Nebr.; Isaac Hird, Manilla, Ia.

The constitution was changed so as to increase the number of the board of directors from six to nine so as to give a better representation for the members from other parts of the country.

The most important business of the convention was the merging of the Iowa Assn. of Cement Users with the Mid-West Cement Users Assn. The Mid-West Cement Show was a success in spite of the bad weather, with all trains snowbound and blockaded practically the entire week. In spite of this the attendance was about 7,000. However, exhibitors reported a good business and had no complaint to make.

Form work for a reinforced concrete floor is at times so carelessly constructed that the ends of the shores or uprights rest on soft earth in such a manner as to allow the beams and girders to sag under the weight of the wet concrete. Where the soil is soft several planks should be crossed in order to get sufficient support to prevent settling under the weight of the concrete.

New Books

Handbook of Construction Plant. By Richard T. Dana, cloth, 4½" x 6½", 702 pp., 312 figs. Myron C. Clark Pub. Co., $5.00.

The contents of this book, which may rival the now famous Gillett's *Handbook of Cost Data* in its particular field, consists of illustrated descriptions of the various machines, appliances and tools included in contractors' equipment, the subject matter being treated alphabetically, thus facilitating the easy use of the book.

The descriptions include practically every type of equipment, as well as cost data, and the text is amplified by many illustrations and tables. The data forming the subject matter of the book, according to the author's preface, have been in use in his office for some time, many of them having been used and verified almost daily. It is stated that for this reason it is felt that rather more confidence can be placed in the usefulness as well as the accuracy of the material than if it had not passed through a fairly thorough period of "seasoning." The author further states that the keynote of the book has been practical utility to the man who has to buy, sell or use a construction plant, or who needs to know what can be done with it. The availability of existing facts in the shortest time on the reader's part, rather than interesting theory and clever comparisons, has been kept most in mind. Because of this, a large wealth of material that will be of interest to the economist and to the engineering student (but for which there is no space in the present book) has been put aside for publication some time later, if it seems desirable.

Directory of Cement, Gypsum and Lime Manufacturers. Published by the *Cement Era*, Ninth Edition, 1915, leather, 3" x 5", 202 pp., illust., $1.00 postpaid.

The 1915 edition of this annual directory presents a complete list of manufacturers of cement, gypsum and lime, so that any prospective purchaser of these products may locate, at a glance, his nearest mill. Machinery and supply manufacturers of products used in the construction and operation of plants; list of brands, alphabetical list of officers, superindents and chemists of cement, gypmond piles, Simplex piles, and pretics on the output of the products are given. By means of this book valuable information is given the consumer, at a nominal cost.

An Efficient Concrete Plant Used on Bridge Approaches

By Everett L. Jones[1]

It is very often the case in construction work that the selection of plant at the beginning of the job may, at the end, enable the contractor to show a gain or a loss; therefore the cost, particularly of the concrete mixing plant, should be carefully considered and the best type erected for the money available.

After careful consideration, the concrete plant shown in Figs. 1 and 2 was selected and erected for concreting the arches on the north approach of the North Side Point Bridge, Pittsburgh.

There were some 10,000 cu. yds. of concrete that could be placed in the area covered by this plant, most of which was in six reinforced concrete arches diminishing from a clear span of 84′ to 45′, as well as the piers and foundations on which they rested.

As the maximum amount of concrete to be placed in any one day of 10 hrs. was 300 cu. yds., the plant was designed with this in view. The principal features of this plant as shown are the distributing chute and boom which were constructed by an entirely new method and adopted by the writer because of the unsatisfactory results obtained from the so-called free-end chutes now on the market, together with the cost of the latter.

HANDLING CONCRETE MATERIALS

All concrete material being delivered by wagon a hole was dug in the street in the rear of the mixing plant and to a sufficient depth below the ground to receive the boot of a bucket conveyor, as shown in Fig. 1, and also to hold 2 cu. yds. of sand or gravel. Over this hole was laid a platform with a trap-door which could be pulled up against the wheels of a wagon, allowing all material to fall inside, instead of being scattered on the ground.

The sand or gravel was hoisted alternately, as desired, by a 45-ft. conveyor into storage bins which had a capacity of 50 cu. yds. of sand and 100 cu. yds. of gravel. From these bins the aggregates were fed by gravity first into a measuring hopper back of the mixer and then into a ¾-cu. yd. Ransome mixer,[2] from which in turn it was dumped into a 40-cu. ft. hoist bucket.

Cement was delivered from the

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[1] Const. Engr., Booth & Flinn, Ltd., Pittsburgh

[2] Ransome Concrete Mchy. Co., Dunellen, N. J.

cars by wagon and unloaded from it directly onto a 26-in. incline belt conveyor which carried the cement bags up and dumped them on a table behind the measuring hopper. From this table an incline chute led into the measuring hopper so that as fast as one bag of cement was dumped another took its place.

Water was fed into the mixer from a measuring tank located on a platform directly over the mixer, the flow of water being controlled by quick-opening valves both on the discharge and the supply pipe. On this platform were also located the levers for controlling the flow of sand and gravel from the storage bin to the measuring hopper and for charging and discharging the mixer, all of which were within reach of one man. To obtain speed at required times two men were used.

CONSTRUCTION OF HOISTING TOWER

The 96-ft. wooden tower was built with 6-in. x 6-in. corner posts halved together at the joints, braced with 2-in. x 6-in. struts and diagonals and guyed with two sets of four guys each, as shown in Figs. 1 and 2. All braces were spiked or bolted to the inside of the 6-in. x 6-in. timbers, leaving the outside free for a sleeve to slide up and down. The sleeve was built about 20′ high on the four sides of the tower and held together with braces and ¾-in. tie-rods, so that the 2-in. x 8-in. timbers would slide on the corner posts.

A ¾-in. wire rope was attached to each of the four corners and run through two equalizing sheaves on top of the tower and from them down the outside of the tower to the hoisting engine. On this sleeve were fastened the receiving hopper, the platform and the 100-ft. distributing chute so that the whole device could be raised or lowered with the wire ropes which led to the hoisting engine, as the chutes were needed for concreting on foundations, piers or arches, either near to or distant from the tower. This arrangement had the advantage of enabling the contractor to make a quick change from one concreting operation to another without having to move the chutes to any great extent or put on additional lengths to bring concrete, for instance, from the top of the tower to the lowest level of the footing.

The boom for the distributing chute was constructed of wood because of its lightness and cheapness, the entire arrangement being built on the job from four 2-in. x 4-in. spruce latticed together by 1-in. x 3-in. plank on all four sides into a stiff member 50′ long, tapering from 2′ 6″ x 2′ 6″ at the middle to about 10″ x 10″ at the ends. One end was fastened to the bottom of the sleeve mentioned above with a wrought iron boom seat, while the other end was held up to the desired angle with two ¾-in. wire cables running through an equalizing sheave fastened on the tower about 18′ above the boom seat. On these cables were strung pieces of 2-in. x 4-in. blocks 18″ long notched out to fit the bottom of the chute which rested on them.

The chute was made from No. 10 iron with straight sides 10″ deep, 9″ wide and a half-round bottom. The sides were flanged out on top and cross-braced with 1-in. angle irons to give additional stiffness, and 10-ft. sections were bolted together with sufficient splice plates to give the iron its full strength. The 50-ft. free end chute was built in the same manner and hung from the end of the boom on a swivel joint. To give this section greater strength a ⅝-in. rod was run from one end to the other through lugs riveted to the bottom of the chute. the rod being tightened by means of turn-buckles.

By constructing the chute in this manner all hog rods and lateral braces were eliminated, making it much more convenient to handle and four men to six men could move the entire chute in a radius of 100′ or less without trouble.

The distributing distance from the tower was increased to take care of the small arches by connecting the free end chute with other chutes suspended from a cable which ran over the tower and anchored in the abutment of the last arch.

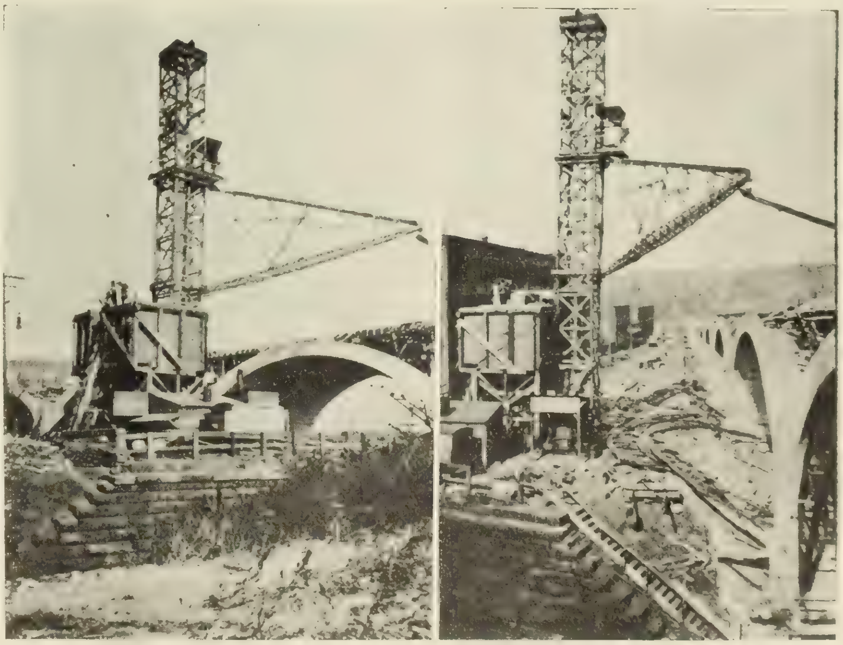
The construction of this chute on the above mentioned lines enabled the contractor to chute concrete at a much flatter angle than the writer has ever been able to do with any other chute now on the market, thus covering a greater area with a shorter tower. Over 8,000 cu. yds. of concrete have passed through the chute without having it clog once, and as this, in some cases, is a cause for much loss of time, the saving ensuing from this type of chute can be appreciated. Taking the original cost and the economy in operations against the amount of concrete to be placed this type of plant might be considered the best that could be erected for this particular piece of construction work and has so proved.

Both mixer and conveyors were operated by electric motors while the concrete was hoisted in the tower by a regular 8-in. x 10-in. hoisting engine.

PERSONNEL

Booth & Flinn, Ltd., Pittsburgh, are the general contractors, for whom M. J. Feeney is gen. supt. and the writer const. engr., in charge of work.

Forks, spades, or other suitable instruments should be used for puddling wet concrete after it has been deposited in the forms. These implements should be small enough to enter well into the space between and around the reinforcing steel.



FIGS. 1 AND 2—ARRANGEMENT OF CONCRETE PLANT USED ON THE APPROACHES FOR THE NORTH SIDE POINT BRIDGE, PITTSBURGH

Fig. 1 shows the bucket conveyor for hoisting sand and gravel to the storage bins of 50 cu. yds. and 100 cu. yds. respectively, located above the mixer

Fig. 2 shows a partial view of the six reinforced concrete arches, varying in span

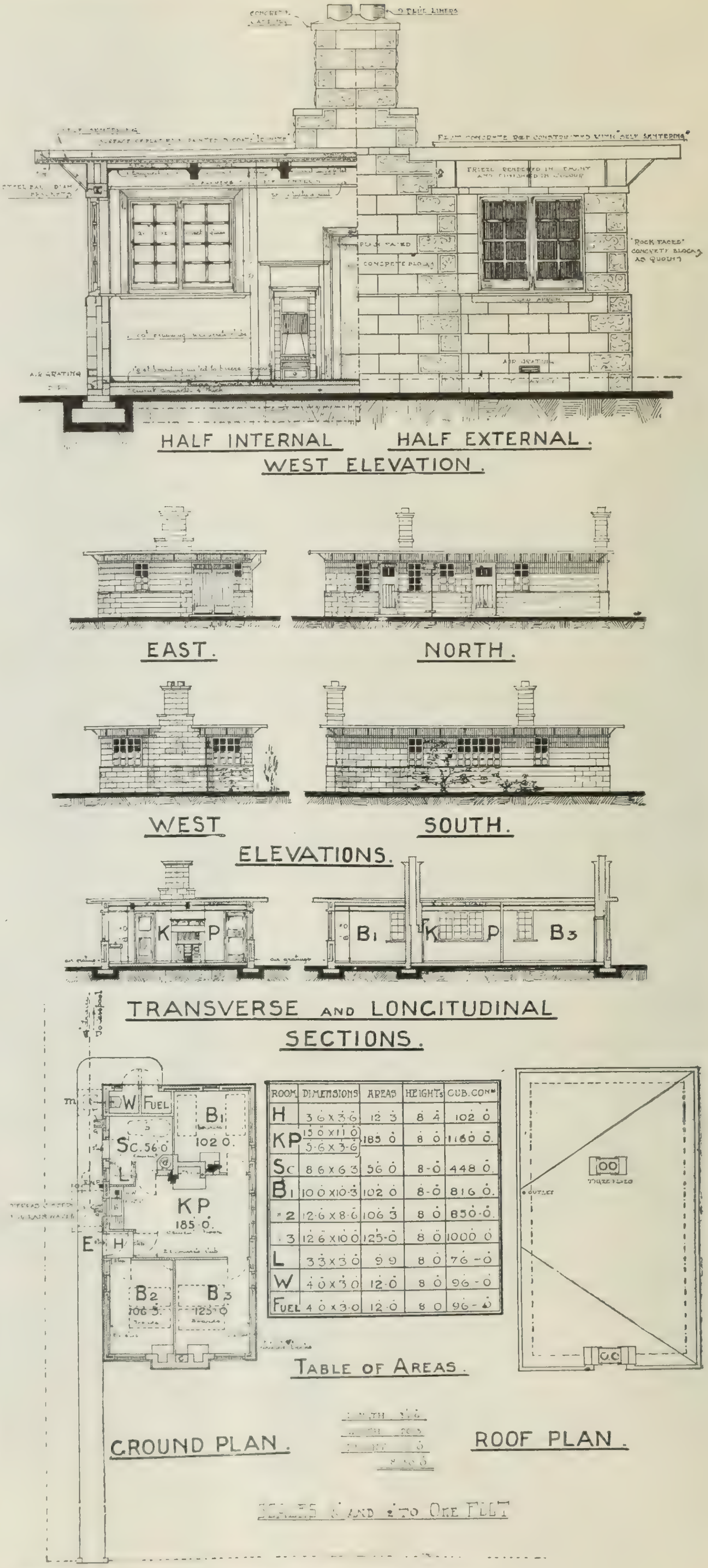
Prize Design in English Farm Cottage Competition

With a view to offering solutions to the problem of economical housing for rural laborers in England, *Concrete and Constructional Engineering* conducted a competition in which prizes were offered for designs for small houses meeting the requirements in question. Through the courtesy of the editors of the English magazine, notes and drawings are here reproduced descriptive and illustrative of the design which received first award.

The first award design is by Ernest S. Thompson. It is of an isolated one-story cottage, in which concrete is used throughout, having an excellent plan with a central living room 185 sq. ft. in area, and three bedrooms, being 102 sq. ft., 106 sq. ft. and 125 sq. ft. in area respectively. There is a scullery 56 sq. ft. in area and food store off the scullery, and a w. c. and fuel store, both entered from the outside. The rooms are 8′ in height, and there is no waste space whatever in the plan, the whole being conveniently arranged with a view to economy of labor in carrying out the domestic duties of the housewife. The windows are so placed that each room will get sun some hours of the day. The flat roof adopted, while being somewhat novel in design, would be a pleasing feature in the scheme, and is skilfully treated so that only one rainwater pipe is required. The author is to be congratulated on his lever treatment of the problem, and it is to be hoped the design will be carried out at an early date. The total cube is £8,130 10s. ($612.06). This sum, according to the conditions, does not include drainage, water supply, sanitary equipment or plumbing, and the work to be carried out by an owner buying his own materials and employing direct labor.

Mr. Thompson's statement of the design, abstracted from *Concrete and Constructional Engineering,* is as follows:

> The cottage provides all the accommodation asked for, is economically planned, sound, cheap and substantial; is one story high, with a minimum use of timber, has good square rooms and no dark corners. Each cottage is detached, and is placed on the site so that every living room gets the full benefit of a southerly aspect. The bedrooms also are lighted with due consideration.
>
> The external walls are of 4½-in. solid concrete block and breeze (cinder) concrete partition slabs 2½″ thick, with a 2-in. cavity in between, well tied together. These slabs would also be used for the partition walls.
>
> The external treatment is extremely simple, depending more for effect upon



ROOM	DIMENSIONS	AREAS	HEIGHTS	CUB. CONts
H	3 6 x 3 6	12 3	8 4	102 0
KP	15 0 x 11 0 5 6 x 3 6	185 0	8 0	1160 0.
Sc	8 6 x 6 3	56 0	8-0	448 0.
B1	10 0 x 10 3	102 0	8-0	816 0.
" 2	12 6 x 8 6	106 3	8 0	850-0.
" 3	12 6 x 10 0	125-0	8 0	1000 0
L	3 3 x 3 0	9 9	8 0	76 -0
W	4 0 x 3 0	12-0	8 0	96 -0
FUEL	4 0 x 3-0	12-0	8 0	96 -0

English Prize-Winning Design for Concrete Cottage proportion and shadow than the use of architectural adornment.

The floors of bedrooms are covered with 1-in. grooved and tongued boarding, nailed direct to the breeze concrete.

The other floors would be finished in granolithic, or concrete tiles.

All internal surfaces of walls would be skimmed one coat, the boarded ceiling stained and varnished.

The drawings will be found quite explanatory of all other necessary points.

Expansion Measurements on a Concrete Factory

Very careful measurements of the Gray & Davis building in Cambridge, Mass., were made, shortly after completion of the building, by Prof. Howard, of the Mass. Inst. of Tech. The builders—Aberthaw Construction Co., Boston—wanted the basis for a study of the expansion and contraction of a reinforced concrete building under temperature variations. A study of the over-all measurements, as well as a study of the movement of vertical lines established on the south front of the building, presents interesting features.

Measurements were made Nov. 7, 1913—a moderately warm day; Feb. 12, 1914—a cold day; Sept. 1, 1914—a hot day.

The varying lengths of the building, measured between points accurately established near the two ends, are given as follows, in each case the measurement given being the average of several determinations:

Date	Temperature, Deg. F.		Length, Ft.	
	Base	Roof	Base	Roof
Nov. 7, 1913..	69.8	56.9	382.559	379.437
Feb. 12, 1914..	17.4	6.2	382.552	379.377
Sept. 1, 1914..	90.	82.	382.580	379.483

The shrinkage in the base with a difference of temperature of 52.4° is apparently 0.007′. At the roof with a difference of 50.7°, the shrinkage was 0.06′. Comparing Sept. with the previous Nov. the base had expanded 0.021′ with a 20° F. increase in temperature, and the roof 0.046′ with a temperature difference of 25° F. It is evident that the variation per degree difference in temperature was much greater on expansion than it was on contraction.

These measurements were made with a standardized 100-ft. steel tape[1] belonging to the Mass. Inst. of Tech., and with proper corrections made for the expansion and contraction of the tape, due to change in temperature. The coefficient of the steel used in the tape was 0.0000063, the tape being standard with an 18.5-lb. pull at 62° F. when unsupported.

The roof measurements were made on the inside of the parapet wall, while the lower measurements were made on the water table running along the base of the building about 2′ above the ground. The various points were established by round-headed brass screws set into lead expansion shields which were well anchored into the concrete wall.

Each measurement was made three times and the temperature taken by three thermometers at the head, rear and middle of each length. In computing for expansion and contraction of the steel tape average temperature for the length was taken.

The stations, as shown in the accompanying sketch, were located about as follows: *A* was about 22′ from the corner of the building; *B*, 79′ from *A; C*, 100′ from *B; D* and *E* each 79′ from the preceding position. This left *E* about 22′ from the east corners. The original establishment of these points on the outside of the building and in the edge of the roof slab was made by a man swung out in a boatswain's chair.

A line was established parallel to the length of the building and about 110′ away. Points were then established on this line to correspond to the five points established on the building and exactly opposite to them. The points established on the top of the building were approximately plumbed down to corresponding points on the water table. A transit was then set up on the base line opposite each point in succession, and the lines plumbed down with a cross-hair, the transit reversed and the lines plumbed again. A brass screw in a lead shield was then put on the water table directly under each upper point.

After this had been done for the entire group of points the operation was repeated as a check and the final established point on the water table was midway between the two, thus found by independent measurements.

The latest measurements to which allusion is especially made in the present article were based upon the original measurements, and indicated the departure of the upper points from their original position with regard to the lower points.

In some ways the most interesting feature of the study is the movement of the points located on the parapet, as compared with the points at the base, which may, for our purpose, be considered as fixed. The accompanying diagram shows by heavy vertical lines the condition in Nov., 1913, when the lines from upper point to lower point were exactly vertical. The dotted line shows in each case the movement of the upper point with regard to the lower, as measured in Feb., 1914; while the dot-and-dash line shows the positions in Sept., 1914. It might be mentioned that the Sept. measurements were made almost exactly 1 yr. after the Aberthaw Co. finished pouring concrete in the building.

While the construction of the building, as measured in Feb., seemed to be about some point between *A* and *B*, it is less easy to fix the location of the point about which expansion took place later, although it must have been not far from *D*. A curious feature, however, lies in the fact that the four sections of the building between measuring points expanded and contracted irregularly. When the building contracted as a whole, one section of the building showed actual expansion, and vice versa. This must have been due to local causes which have not been determined—possibly to interior conditions of heating.

Soft soap may be used instead of oil for lubricating the forms when the inflammability of the oil is objectionable, as soap boiled and applied hot to the forms gives very good results in preventing the adhesion of concrete to forms.

In placing concrete in floor slabs, girders and beams, the work should, if possible, be carried along in a straight line from the section of the building which is being concreted. Unless adjoining masses of concrete of different depths, like adjacent girders and slabs, have the puddling or ramming operation carried down as thoroughly through one as the other, initial setting cracks are likely to form between the masses of different depths.

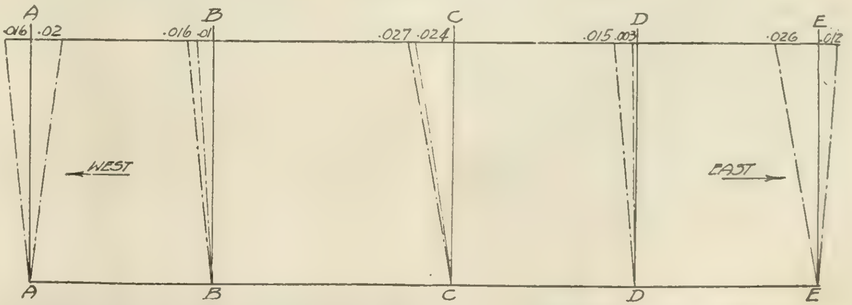


Diagram Showing Expansion Measurements on a Factory Building at Cambridge, Mass.

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[1] Lufkin Rule Co., Saginaw, Mich.

Concrete Fence Posts for Lackawanna Railway Lines

An ideal location is the first requisite for economy of manufacture in a concrete fence post plant and in this particular railroads have peculiar advantages. The D. L. & W. Ry. Co. has installed additional equipment for making fence posts in a well located and economically arranged plant upon its lines at Nichols, N. Y.

It is alongside tracks which are somewhat elevated from the surrounding ground and the plant consists of a main shelter shed without sides—merely a protection from the weather for the plant equipment of mixer, molds and tools used and for the men while working. There is also an enclosed building for housing the cement, which is unloaded with an inclined chute directly from the cars into the shed.

The gravel is brought to the plant in bottom-dump cars and dropped through trestle work to clear the tracks. It is conveyed to the mixer by wheelbarrows up a slight incline as needed and dumped directly into the mixer, the feeding hopper of which is on the level of the floor of the cement shed; thus the mixer is filled economically. The mixer is of the batch type, operated by steam.

A large-sized mold[1] is used, which is $3\frac{1}{2}''$ wide at the top and $5\frac{1}{2}''$ wide at the base, 7′ 6″ long, U-shaped in cross-section, making a post with a round back and a flat face, each mold being complete in itself, with detachable ends which are seldom removed. For convenience and economy of filling, the molds are grouped together upon a supporting table holding eight molds at one time. Sufficient concrete to fill all eight molds is dumped from the mixer at one operation, leveled off and the reinforcement, consisting of hoop steel $\frac{5}{8}''$ wide and about $\frac{1}{16}''$ thick, is placed, four lengths per post, weighing slightly more than 3 lbs. for the four lengths.

Concrete of the consistency of mortar for wall plastering is used which allows it to adjust itself readily to all parts of the mold and around the reinforcing bars. A slight application of oil is made on the forms with a handful of waste to keep the concrete from sticking.

When the molds have been filled and the lower reinforcing bars placed, the molds are given a horizontal, vibratory shaking by the use of vertically set supporting springs of a rack, or so called "shaker," which holds the molds in a bed which is the right distance from the ground to work easily for filling and removing. This is a part of the D. & A. equipment. This shaking gives the posts greater density and better surfaces.

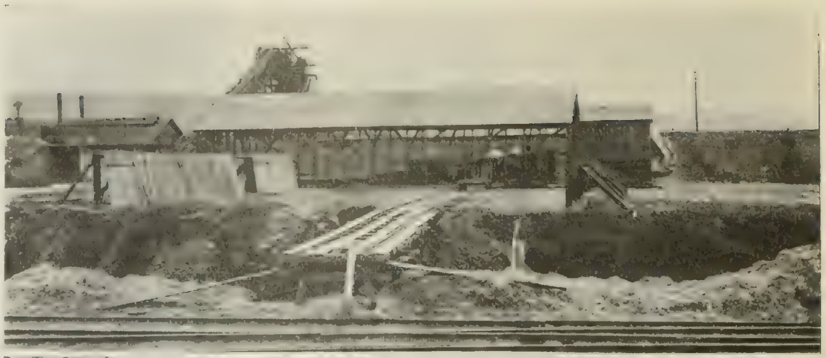

Fig. 1—General View of Storage Yard Showing Track to Railway Siding

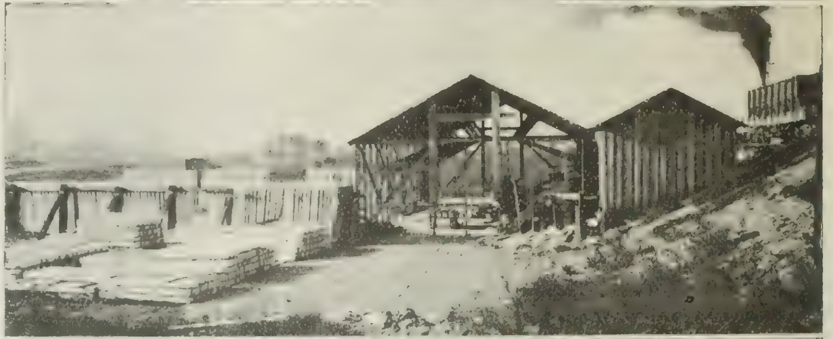

Fig. 2—The Elevation of the Railroad Above the Molding Floor of the Shed is of Great Advantage in Delivering Materials

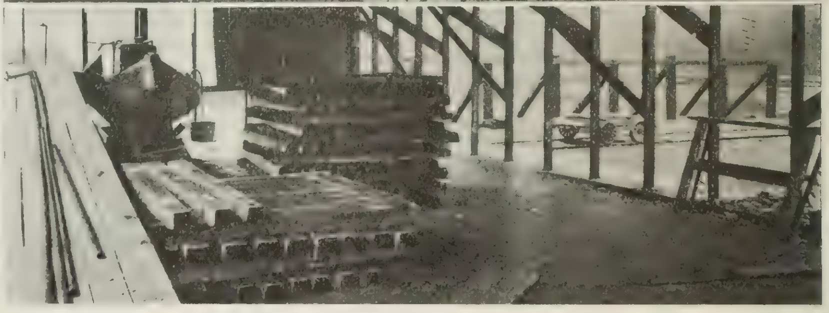

Fig. 3—Showing Position of Mixer, Molds and Elevated Runway Above Mixer

After hardening for about 24 hrs., under normal conditions, the line posts are removed from the molds and stood upon end against solid supports. A piece of 2-in. timber is placed between alternate layers of posts as stacked, near the top end, in order that the slant may not increase and cause excessive strain against the support.

Upon removing the molds from the posts, the molds are ready to use over again. When through making for the reason the molds are well oiled inside and out, and stacked for storage. The oiling protects them from corrosion.

Anchor posts are used, square in cross-section, 5″ at top and 7″ at base, 8′ long. These are piled similar to lumber, with cross-strips at each end only. A spur track runs to the post piles for loading upon cars for distribution over the lines of the system.

These concrete fence posts are now standard upon the Lackawanna system, and they have been in use since the spring of 1910. More than 100,000 have already been made at the plant at Boonton, N. J., and most of them set along the road's lines in N. J., Pa., and N. Y.

The fence is fastened by the use of short pieces of soft wire which are wrapped to the line wire at each side of the post in what is familiarly known as the "Western Union twist."

The fact that the railroad company continues to make posts in quantities, and that it is installing increased facilities means that the posts are proving a success after several years' use. This is only one of a score or more railways using one kind or another of concrete posts with success, and it only a matter of time when they will be quite universally used.

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[1] D. & A. Post Mold Co., Three Rivers, Mich.

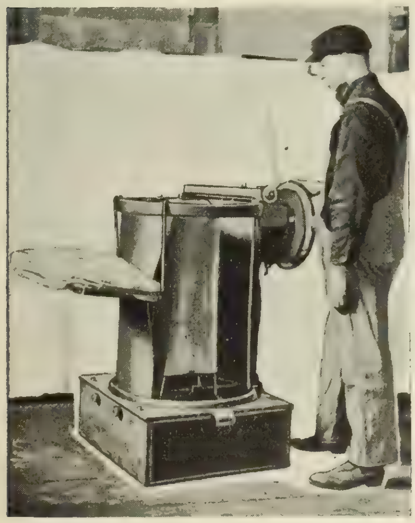
New Equipment, Methods and Materials:

New Tools with Which the Industry Works

This magazine will not publish "reading notices," so-called, for the benefit of advertisers. These pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers are constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.—The Editors.

A New Bag Cleaner, with Counting Device

Few contractors realize the large amount of cement returned to the mills in empty sacks. It is claimed that from 6 oz. to 10 oz. of cement are returned with each sack. Figuring only 4 oz., after having shaken the sack by hand, would give approximately 800,000 sacks of cement that go back to the mill, or are wasted each year. At $1.50 per bbl., this waste would mean about $300,000.



The Century Bag Cleaner with Counting Device

The side of the machine has been cut away in order to show the bag on the beaters or vibrators. The boy is ready to clean the bag by giving the crank a few turns. The cement from the bag drops into the base of the machine, with a door for removing the cement.

The accompanying illustration shows the portable Century bag cleaner,[1] which offers a clean, easy and efficient means of cleaning and counting empty sacks. It is simple in construction, light in weight and easily moved from one job to another. All bearings are properly protected against cement dust and are readily accessible for oiling.

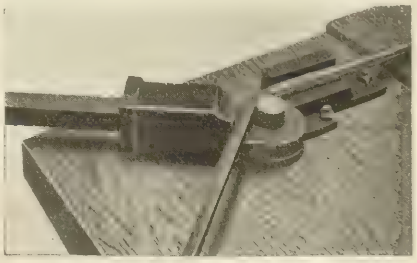
The machine is furnished for operation by hand or by power, and with or without counter. The hand machine does not run hard, but of course, will not clean sacks so rapidly as the power machine. Very little power is required for operation. The power machine has an 8-in. x 12-in. pulley of from 200 r. p. m. to 250 r. p. m., and requires about ¼-h.p.

It is claimed that either the power or the hand machine is so simple in operation that an ordinary laborer or a boy can run it. The bag is dropped onto the two beaters or vertical steel rods bent in the form of an inverted U, as shown in the accompanying illustration. The beaters or vibrators, when set in motion by turning the large wheel by hand or by power, vibrate back and forth under the sack and cause the cement to drop out of the corners and from between the fibers of the sack. The sack is said to be thoroughly cleaned after two or three turns of the crank or pulley. The machine is then stopped with the beaters together, so that the arm can be pushed back in order to remove the sack and at the same time count it. When 50 sacks are cleaned, a bell rings to notify the operator to tie up the bundle.

It is said to take a boy from 30 min. to 40 min. to clean and bundle 100 sacks.

The U Bar Bender

The accompanying illustration shows the Universal bar bender,[1] which may be fastened to any bench or plank. It is a light, portable device weighing about 60 lbs. and capable of bending all ordinary sizes of reinforcing bars to any angle desired, without any adjustment being necessary. The top half of the bender can be removed and used to bend bars after they are in place. The bar rolls around the pin in bending,



Universal Bar Bender

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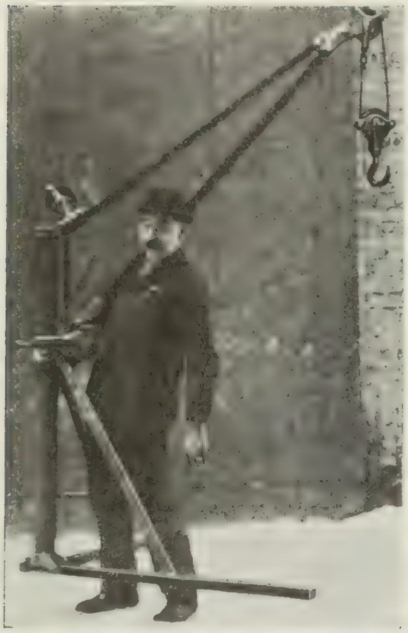
[1] Century Cement Machine Co., 62 Brown's Race, Rochester, N. Y.

[1] Neevel Mfg. Co., Kansas City, Mo., or The Universal Stamping Co., Ltd., Strasburg, Pa.

thus distributing the strain along the bar and reducing the chances of fracture at the bend.

The bender is equipped with a 5-ft. crowbar for a handle, which may be removed and used for other purposes. To bend large bars easily, the handle should be lengthened by using an iron pipe over the crowbar.



New Model Sasgen One-Half-Ton Portable Circle-Swing Builders' Derrick

A New Portable Circle-Swing Builders' Derrick of 1,000 Lbs. Capacity

The accompanying illustration shows one of several styles and sizes of Sasgen derricks[1] for building contractors. This derrick, known as the Steel Champion, has a height of 7′ 6″ and weighs only 200 lbs. It has a capacity of 1,000 lbs. and is equipped with 110′ of crucible steel cable, hoisting block, self-lubricating bearings and fasteners.

The bottom sills and mast fold together, making the derrick in two parts and compact enough so that it can be taken from job to job in the contractor's automobile. The boom extends 5′ and can be removed in a few seconds by loosening one nut and raising the boom 2″.

The derrick may be operated by hand, horse or power.

A New Type of Hollow Concrete Floor Construction

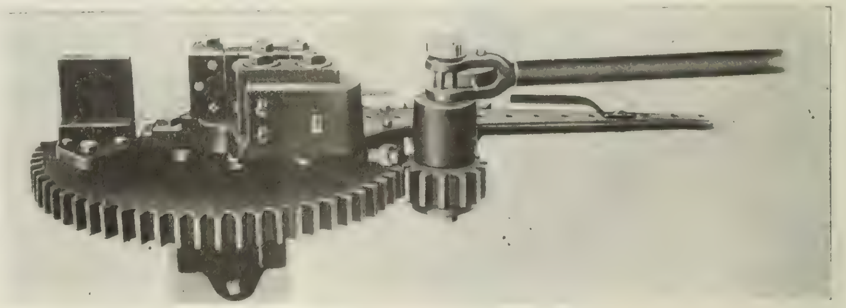
The accompanying illustration shows the Sanden system of hollow concrete floor construction,[1] designed to eliminate the use of temporary centering as in ordinary reinforced concrete work. It is composed of reinforced concrete T-beams, constructed by means of hollow concrete forms, 7½″ high and 16″ wide on the bottom. The forms act as a filler and rest on the brick wall or frame into concrete or steel beams, being made of any span desired. The main reinforcement for the floor sys-side sloping up under the track be-tem is placed between these forms, as shown, with some additional bars in the top of the T at right angles to the joists. The concrete is poured in the same manner as with hollow tile and joist construction, being from 2″ to 3″ thick over the forms (usually 2″).

The Sanden floor system is especially adapted to dwellings and office buildings. The hollow space in the forms may be used for pipes, wires, etc., and is claimed to be of considerable advantage in deadening sound. The dead load is said to be small and it is claimed that fewer beams are required than in ordinary concrete floor construction.

A New Bar-Bending Tool

The accompanying illustration shows one of several styles and sizes of the Wallace bar benders.[1] This apparatus can be operated by one man, and will bend reinforcing bars up to 1¼″ in size, without heating the bars.

The machine has an auxiliary ratchet lever, which operates a pinion against a series of teeth in the frame, thus exerting considerable power. The ratchet pawl may be thrown out of engagement and the machine operated with the regular lever or handle as shown, thus making it possible to bend light bars cold at a very rapid rate. The machine is fitted with anti-friction rollers on the handle and with a special dog to prevent back-lash. All dies have tool steel face-plates.

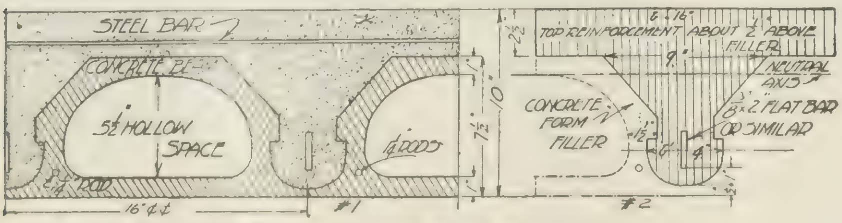


New Type of Wallace Bar Bender

A Portable Car Unloader for Handling Sand and Gravel

An unloading device, shown in the accompanying illustration, has recently been placed on the market. Such a device, known as the Eclipse portable car unloader,[2] is used for unloading sand, gravel, broken stone, etc., from hopper-bottom railroad cars to a bin or a wagon as fast as the material can run out of the hopper of the storage bin. It is designed to speed up work, save expense and number of men and develop the full efficiency of motor trucks or wagons by reducing the time taken in loading. Unless the loading is practically instantaneous, much of the advantage of the motor truck is lost, as its great advantage is speed, i. e., the number of trips it can make per da.

The unloader is very simple in construction, being mounted on heavy steel trucks, with a wooden hopper



The Sanden System of Hollow Concrete Floor Construction bin, of either 18 tons or 50 tons capacity, on posts sufficiently high to allow loading from this hopper by gravity into wagons or trucks. At the lower end of the wooden frame are hinged legs which are let down and take the load off the wheels and axles, except when the unloader is being moved. From the base of the rectangular derrick frame, mounted on top of the hopper, is a wooden trackway leading down to the ground. A cable leads from a gasoline hoist, mounted in the frame below the bin, to a pulley block at the top of the derrick frame, and then to a ¾-yd. A pulley block at the top of the derrick frame, and then to a ¾-yd. bucket which moves up and down the trackway.

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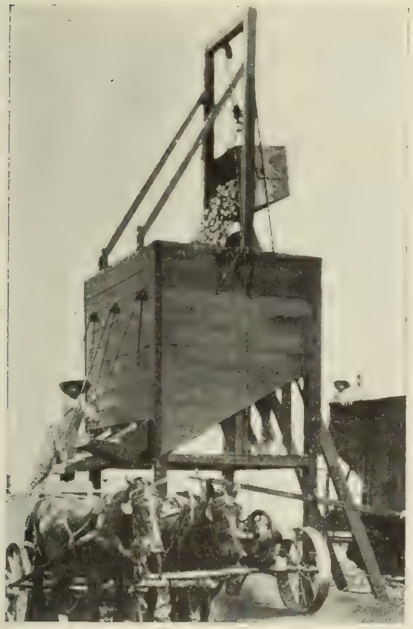
[1] The Sasgen Derrick Co., 2053-57 Racine Ave., Chicago

[1] Arthur Sanden, 5623 Catherine St., West Philadelphia, Pa.

[1] Wallace Supplies Mfg. Co., 414 Orleans St., Chicago

[2] The Galion Iron Works & Mfg. Co., Galion, Ohio



Eclipse Portable Car Unloader

In setting up the unloader a small pit is dug beside the track, with one tween two ties to accommodate a chute which catches the stone as it drops from the bottom of a hopper car. The chute is equipped with a gate to control the run of stone from the car. The bucket is lowered into the pit, the chute gate lifted and the stone allowed to run into the bucket until it is filled. The gate is then closed and the bucket is hoisted and dumped into the unloader bin. Chutes in the lower side of the bin are provided for loading the material into wagons.

The manufacturers claim that only one man is required to operate the device, and that it handles 40 tons of crushed stone per hr. at a cost, from the car to the wagon, of about 2 cts. per cu. yd.

A Sack-Baler With Counting Device

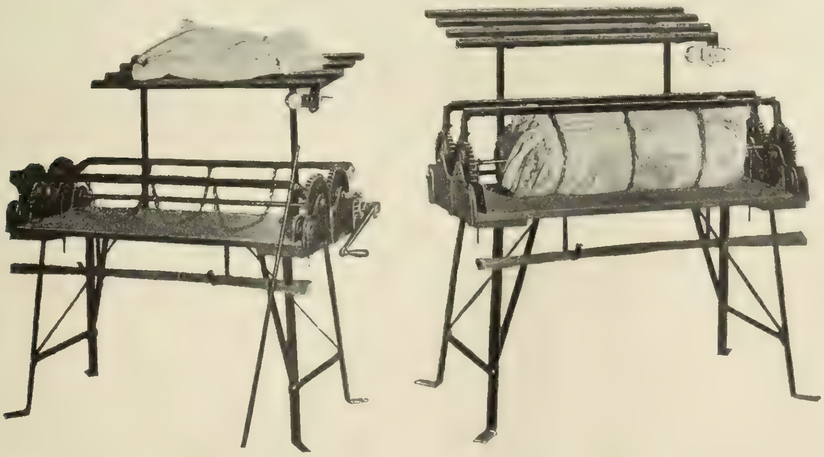
The Economy[1] sack-baling machine shown in the accompanying illustration is constructed entirely of steel and iron, with the exception of the table and the sack shelf. The leverage obtained through the operation of gear-wheels running on roller-bearings is said to be such as would enable a boy eight years old to bundle sacks so tightly that a sack could not be removed while the wires were intact.

The machine is very simple in operation. The sack shelf is intended for the convenience of having the sacks to be bundled directly before the operator, so that in laying the sacks out flat in the machine he does not have to stoop to pick them up. Such an arrangement also enables the operator to get a better view of the sacks, thereby detecting any foreign or damaged sacks.

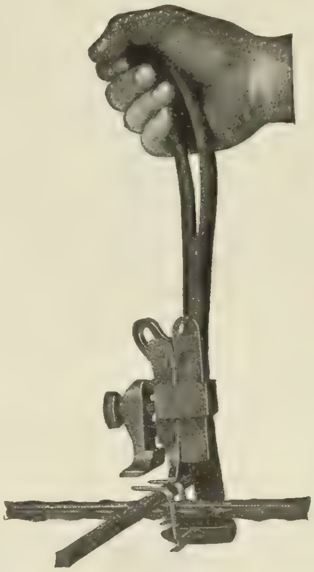
When taking sacks from the shelf, the operator trips the lever on the counting device with the edge of his right hand. The counting device is set at OO, and has a dial showing the number of sacks that have been placed in the machine. When the counter has been tripped 50 times, a bell rings and the counter automatically clears itself to OO.

An advantage claimed for the counting device is that it becomes mechanical for the operator to trip the lever and if his attention is detracted from his work it does not interfere with his count, as the bell will ring when 50 sacks have been put into the machine.

After 50 sacks have been laid out flat in the machine, it requires but one turn of the crank to roll the bundle up in a neat, tight roll, and the wires coming up with the side arms are exactly on top, ready to twist. It takes but a moment to twist these wires. A ratchet on the gear-wheels holds the machine tightly until released.



Sack-Baler, with Counting Device



The Universal Clincher for Fastening U Support-Ties

A New Device for Clinching U Support-Ties for Reinforcing Bars

In order to improve the efficiency of the ordinary common laborer usually employed for placing reinforcing bars in position in the form, the Universal clincher[1] shown in the accompanying illustration has been placed on the market for the purpose of clinching U bar support-ties. These ties are described in the issue of Nov., 1914, p. 226.

This apparatus fastens the bars together quickly and in a secure manner, and can be used on any size or shape of bar. It is provided with a hook for the purpose of raising the bars when placing the U support-ties. After the clincher has been placed, pushing down the handle completes the operation.

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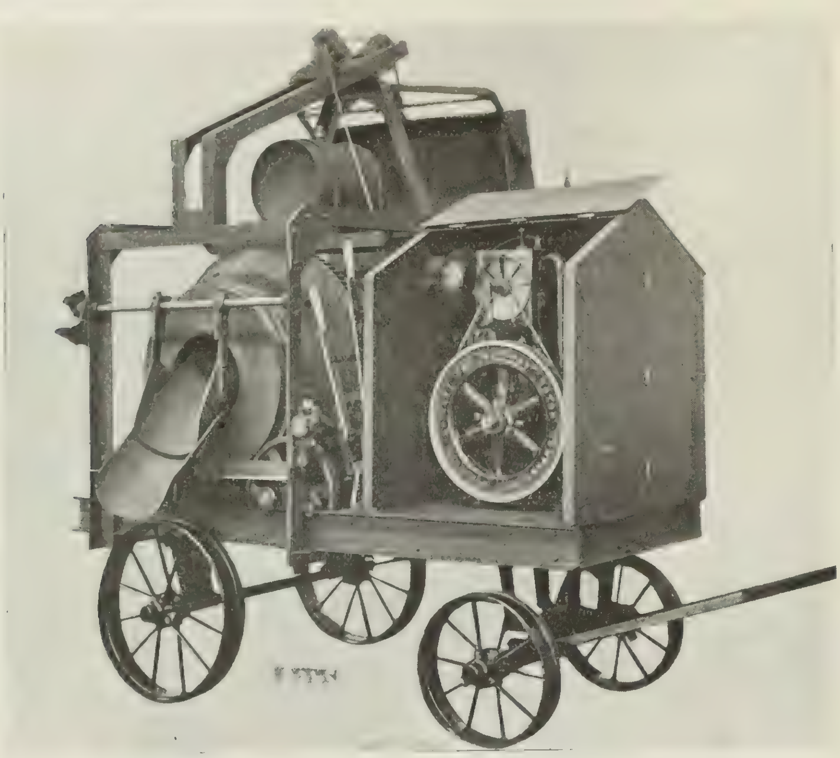
[1] Wright Bros., Litchfield, Ill.

[1] Universal Stamping Co., Ltd., Strasburg, Pa.

It is claimed that with this device an untrained man can start out at once to apply from 8 ties to 12 ties per min. and with little practice can do much better.



The Eureka Concrete Batch Mixer

A New Small Concrete Batch Mixer

A new concrete mixer of about 3½ cu. ft. (mixed concrete) capacity, designed especially for sidewalk and paving contractors, is the Eureka No. 5 mixer.[1] This mixer may be placed between the forms on a sidewalk job and the concrete discharged in place, thus saving the time of several men who would otherwise be wheeling mixed material to the forms. It may also be placed so that concrete may be dumped directly into forms on footings.

The mixer is mounted on an all-steel truck with three-point suspension as shown in the accompanying illustration. The rear wheels of the truck are 24″ in diam. and the front wheels 18″ in diam., with 4-in. face. The main frame is 6′ 11″ long, 36″ wide, with 5-in. 6½-lb. channels.

A sideloader of the pivoted type with an automatic clutch release, holding 5 cu. ft. of loose material, is furnished with the mixer. A batch hopper of the same capacity can be furnished instead of the sideloader when desired.

The mixer drum has double cones of unequal tapers comprising only three parts; the large semi-steel conical head with gear, and a similar slightly rounded head joined together by a shell of heavy boiler plate steel. The series of mixing blades and buckets is arranged to give a uniform mix and to discharge rapidly and cleanly. The trunnion rolls are 15″ in diameter with 1$\frac{1}{16}$-in. face and pinned solidly in pairs on a 1$\frac{7}{16}$-in. shaft, the shaft revolving in babitted bearings 4″ long. The water tank is of the positive measuring type, 18″ long, 14″ in diam., with a capacity of 12 gals. at 100 lbs. working pressure.

The engine used on the Eureka No. 5 mixer is a 3½-h.p. New Way[2], air-cooled engine, of the regular gasoline type. An electric motor to drive the engine can be furnished when desired. The engine is enclosed in a protecting steel housing.

Bonanza Cement Tile Roofing—American Cement Tile Mfg. Co., Pittsburgh, paper, 9¼″ x 6¼″, 40 pp., illust. This two-color catalog describes in detail concrete tile for pitch and flat roofs as applied to industrial buildings. The photographs illustrate actual installations, the roofs of the buildings being colored red in the illustrations. A panoramic view of Balboa terminal at the Pacific end of the Canal Zone is also shown. The catalog is neatly arranged and the illustrations serve well their purpose.

Trade Publications □

Bulletin AC Wheels and Caster—The George P. Clark Co., Windsor Locks, Conn., paper, 6¾″ x 5″, 48 pp., illust. This bulletin contains description and price list of rubber wheels made by this well known firm. The information is concisely presented and at the same time conveniently arranged.

Data on Gager's Hydrate, Ellis Soper, M.E.—Gager Lime & Mfg. Co., Chattanooga, Tenn., paper, 7″ x 4¾″, 10 pp., illust. This booklet contains statements and data regarding hydrated lime. Several tables give the amount of hydrated lime for use in common mortar, plastering, stucco, Portland cement mortars and concrete.

Peerless Motor Trucks are the Trucks for Contractors, Road Builders and Building Supply Houses—Peerless Motor Car Co., Cleveland, paper, 8″ x 5½″, 16 pp., illust. Numerous well selected illustrations are printed, showing the use of these trucks by contractors on heavy construction work of various kinds.

Palmer-Moore Trucks — Palmer-Moore Co., Syracuse, N. Y., paper, 4″ x 9″, 6 pp., illust. Detailed specifications covering the 1,600-lb. capacity Palmer-Moore trucks. Numerous illustrations are also given showing their application in various industries.

Bulletin No. 10, Versatile Varnish—Dielectric Mfg. Co., St. Louis, paper, 6¼″ x 3½″, 4 pp. This folder contains prices in dozen lots on the Versatile varnish.

From Stone Cold to Full Power in 10 Seconds, The Harris Valveless Engine—Harris Patents Co., N. Y. C., paper, 11¼″ x 8½″, 14 pp., illust. This bulletin takes up in detail the advantages of the Harris valveless engine for vessels, tugs, police, pilot and fire boats, light-ships, battleships and submarines, passenger vessels and auxiliary vessels. The Diesel principle as applied to Harris valveless engines is also fully illustrated. The second part of the bulletin considers the advantages of the Harris valveless engine for general power purposes, generating electricity, railroad motor power, etc. The bulletin is in lose-leaf form with a cardboard cover.

The Famous "Crescent" Concrete Sewer Pipe and Drain Tile Molds, Catalog 11—Raber & Lang Mfg. Co., Kendallville, Ind., paper, 10¾″ x 7½″, 30 pp., illust. This catalog considers in a very interesting manner the manufacture and use of concrete tile and pipe, describing at the same time the molds used in making them.

Weber Chimneys—The Weber Chimney Co., Chicago, paper, 9¼″ x 5″, 48 pp., illust. This well illustrated booklet gives views showing many Weber chimneys now in use, being accompanied by a long list of users, in many parts of the U. C., Canada and foreign countries.

Scandinavia The Cement Belt—Scandinavia Belting Co., N. Y. C., paper, 3¼″ x 6″, 16 pp., illust. The several merits of Scandinavia belting for transmission, conveying and elevating are discussed in this booklet. The belting is especially constructed for cement work.

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[1] Eureka Machine Co., 14 Case Ct., Lansing, Mich.

[2] New Way Motor Co., Lansing, Mich.

Concrete-
Cement Age

Vol. 6 *Detroit, May, 1915* *No. 5*

The Occasion of a Letter from Mr. Edison

THOMAS A. EDISON'S letter reproduced on the following page (226) leaves little if anything to be said in answer to the misinformation about the Edison fire which has been given wide circulation by clay brick interests. Mr. Edison suffered a disastrous fire. It was of most serious consequences in its interruption of his business. Some of the buildings were of reinforced concrete and some of brick and steel. The brick and steel buildings which were attacked by the fire were a total, 100%, loss; the concrete buildings were a 12½% loss only, and that in spite of some features of their design and construction now considered obsolete, and in spite of an almost complete lack of any provisions such as steel sash and wire glass to prevent the spread of flames through wall openings. Mr. Edison is using concrete exclusively in rebuilding. These facts are well established and have been well established for several months through the investigations of an unprejudiced committee of great ability and integrity. There is no possibility of finding anywhere in the situation any arguments in favor of the use of brick and steel construction in preference to reinforced concrete. Concrete demonstrated its worth under what was probably the most trying test ever made of building materials.

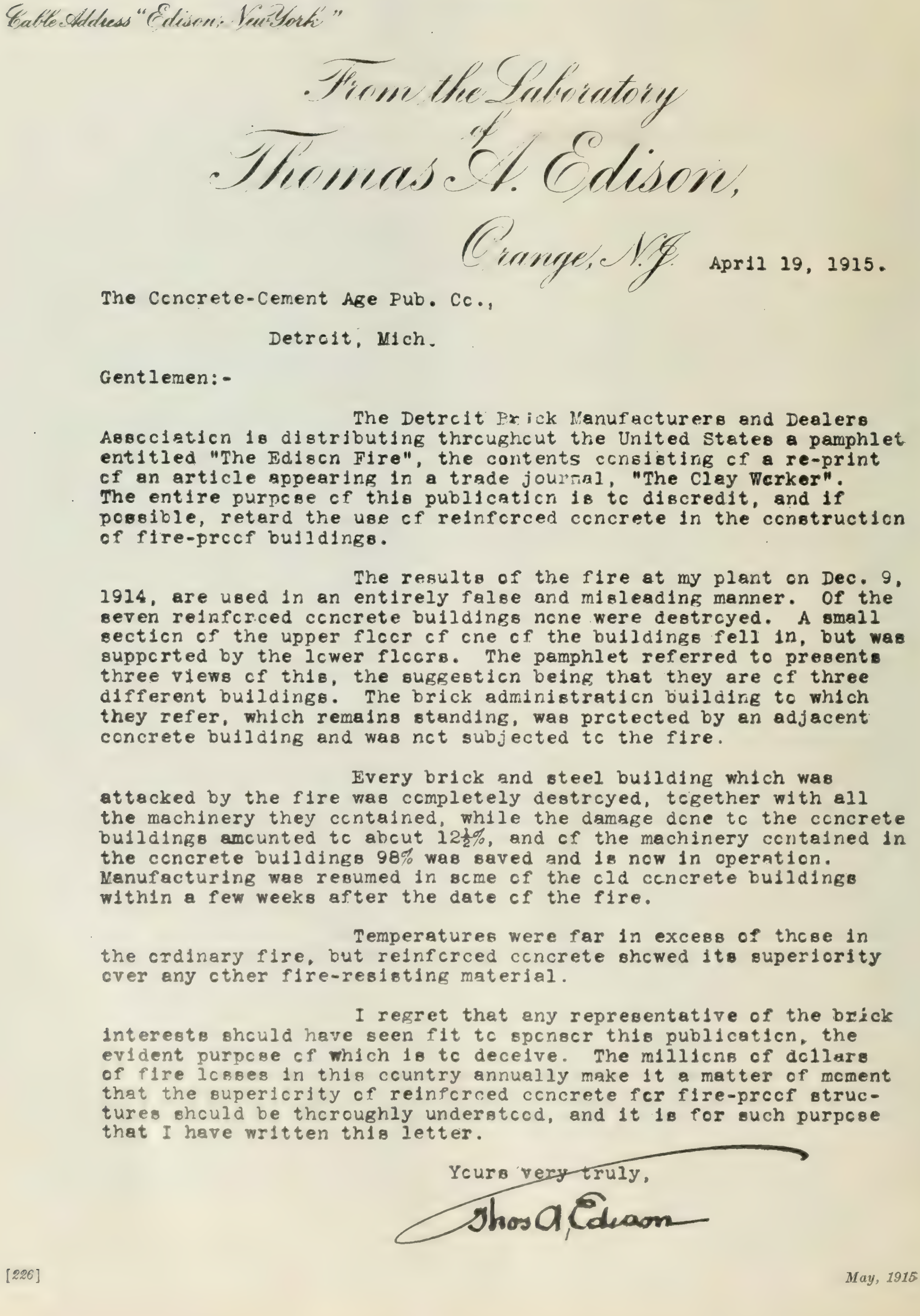
It is very difficult to find the wit in such a piece of literature as that given wide circulation by the Detroit Brick Mfrs. and Dealers Assn. CONCRETE-CEMENT AGE some time ago ceased to pay very much attention to the things produced by some misguided and short-sighted "brick writers." "Concrete" has other things to do. It has use for its pages in giving practical information on how to achieve the best with concrete. In this it is being given the splendid assistance of the experienced users and makers of concrete. The brick makers and the brick papers have a similar work to do. They have much to achieve. Invective will not help them. Such literature as that answered by Mr. Edison discredits them. They have just that much to "live down." It is hard to believe that such a silly and obviously untruthful attack as that in the pamphlet especially referred to has the countenance and approval of the good business men of the brick industry who are trying to build up their industry on an honest and decent basis. It must embarrass them to appear even as remote sponsors for these bearers of false witness; or in another view, to be laughed at for trying to "get across" with anything so asinine—statements which admit of such a complete and unanswerable come-back as the letter from Mr. Edison.

Building Regulations in Massachusetts

IN the revision and uniform codification of the Building Laws of the State of Mass., one feature of the old law is left which seemed to invite considerable peril to the home-dweller. The well known three-flat wooden apartment house, so prevalent through New England, is permitted to remain and is not required to be built of concrete or other fireproof material. The new law states that such buildings must be covered with cement or plaster, however, in order to lessen the risk of fire spreading. Professor Killam, who is a member of the Commission, points out that while the three-floor houses of wood were not put under the ban, their danger was minimized and that under the local option features of the proposed general state statute, towns and cities and even subdivisions of municipalities might shut them out if they chose to make regulations to that effect. Meanwhile, the danger spot remains and some fire accompanied by loss of life may draw special attention to the distinguished professor who is willing to allow this dangerous form of dwelling house to remain without fireproofing.

According to the report of the committee appointed to consider the matter of combustible roof coverings in the Bay State, it is recommended that every municipality in the district shall pass an ordinance requiring the use of fireproof covering on all roofs and dormer window tops. Fire Prevention Commr. O'Keefe is to communicate this recommendation to every city and town in the district. The finding of the committee is the outcome of an extended investigation which decided in favor of fireproof roofs over the wooden shingles now so largely used throughout the New England states. This regulation is already in force in Salem, which had a bitter experience.

A Letter from Thomas A. Edison



Cable Address "Edison, NewYork."

From the Laboratory
of
Thomas A. Edison,
Orange, N.J.

April 19, 1915.

The Concrete-Cement Age Pub. Co.,
Detroit, Mich.

Gentlemen:-

The Detroit Brick Manufacturers and Dealers Association is distributing throughout the United States a pamphlet entitled "The Edison Fire", the contents consisting of a re-print of an article appearing in a trade journal, "The Clay Worker". The entire purpose of this publication is to discredit, and if possible, retard the use of reinforced concrete in the construction of fire-proof buildings.

The results of the fire at my plant on Dec. 9, 1914, are used in an entirely false and misleading manner. Of the seven reinforced concrete buildings none were destroyed. A small section of the upper floor of one of the buildings fell in, but was supported by the lower floors. The pamphlet referred to presents three views of this, the suggestion being that they are of three different buildings. The brick administration building to which they refer, which remains standing, was protected by an adjacent concrete building and was not subjected to the fire.

Every brick and steel building which was attacked by the fire was completely destroyed, together with all the machinery they contained, while the damage done to the concrete buildings amounted to about 12½%, and of the machinery contained in the concrete buildings 98% was saved and is now in operation. Manufacturing was resumed in some of the old concrete buildings within a few weeks after the date of the fire.

Temperatures were far in excess of those in the ordinary fire, but reinforced concrete showed its superiority over any other fire-resisting material.

I regret that any representative of the brick interests should have seen fit to sponsor this publication, the evident purpose of which is to deceive. The millions of dollars of fire losses in this country annually make it a matter of moment that the superiority of reinforced concrete for fire-proof structures should be thoroughly understood, and it is for such purpose that I have written this letter.

Yours very truly,

Thos A. Edison

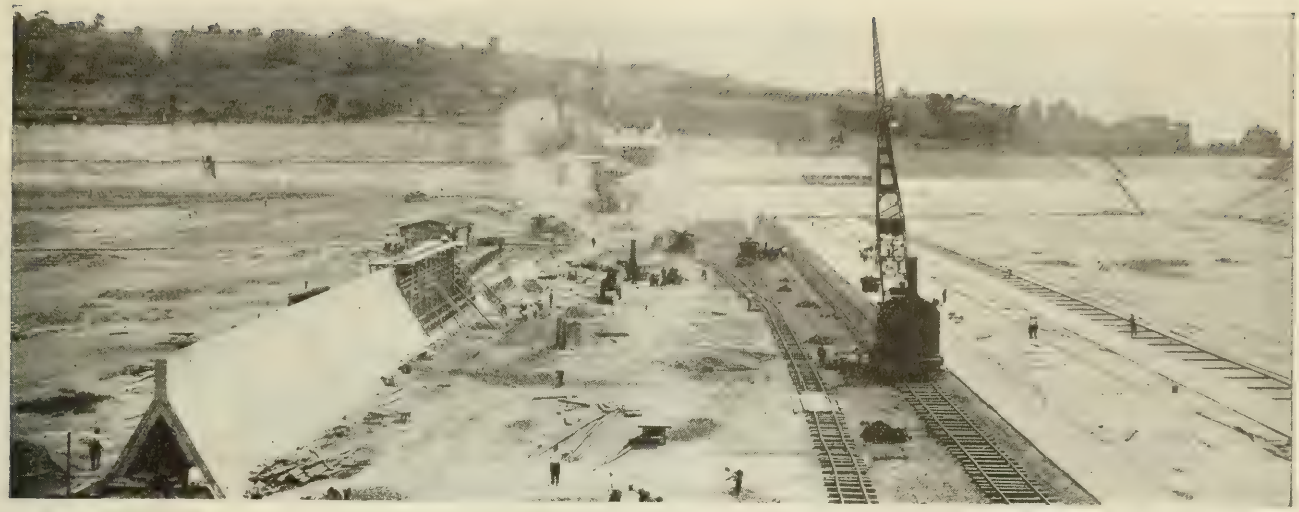


Fig. 1—View of Combined Dividing Wall and Inlet Conduit of North Side Reservoir, of Pittsburgh, Under Construction

Design and Construction of the North Side Reservoir of the Pittsburgh Water Works

The design and construction of the new North Side (Cabbage Hill) reservoir of the Pittsburgh water works are here described from information furnished by the Pittsburgh Industrial Development Comm.; Hartley M. Phelps, Pittsburgh; and from a paper by E. E. Lanpher and J. S. Cole before the Engrs.' Soc. of Western Pa., the full paper and discussion being published in the Oct., 1914, Proceedings.

The reservoir is to help supply the North Side, or the old City of Allegheny, and the low-lying section of old Pittsburgh, with filtered water; this work is now being done in part by the Highland reservoir No. 2, on the old city side of the river. A 48-in. steel main has been constructed under the Allegheny river at 26th St., by means of which the water from the new basin will be distributed to the downtown section, the flat lands of the South Side and the lowlands of the West End. The Highland reservoir has a capacity of 130,000,000 gals., so that the two basins have a combined capacity of nearly 300,000,000 gals. As the North Side requires but 35,000,000 gals. daily, and the low-lying part of the old city about 40,000,000 gals., the two reservoirs will hold sufficient water to supply the sections mentioned for four das.

GENERAL DESIGN

The reservoir has a capacity of 160,000,000 gals. with a water area of 17 acres and a water depth of 38′. It has been built by the cut and fill method, three sides being built of rolled embankment, the remaining side being entirely in cuts, surrounded by a reinforced concrete retaining wall along a public roadway.

The reservoir is divided into east and west basins by a reinforced concrete dividing wall 18′ high (see Figs. 1, 2 and 3), containing the inlet conduit which connects the main, or inlet and outlet gate house in the northerly embankment, with the distribution or secondary gate house in the southerly slope.

Embankments. — The embankments have a slope on the outside of 2:1 for a height of about 20′, where there is a 5-ft. berm, as shown 1¾:1 for 20′. On the inside, the slope is 2:1 from the bottom to in Fig. 4. Above this, the slope is the top, the height being about 42′ above the floor of the basins. The top of the embankment is 15′ wide; the maximum width of the foot is 185′. The outside of the embankment was scored and covered with 6″ of top soil, which was seeded and sodded.

Main Gate House.—The main gate house foundation, a reinforced concrete structure, 42′ x 38′ in plan, extends from bed rock to the top of the northerly embankment. It was poured in two horizontal sections and five vertical sections, and contains about 800 cu. yds. of concrete.

In the main gate house, a waste weir is provided against overflowing, the water being carried to the main drain, a 36-in. circular conduit 2,300′ long, running to a small stream which discharges into the Allegheny river. Other drains along the roadway, the sides of the reservoir and herring-bone drains under the floor system along the southerly and the easterly slope discharge into this 36-in. drain.

Retaining Walls.—The reinforced concrete retaining wall extends for 875′ along the southerly side of the reservoir. It varies in height from 2′ to 21′ 9″. The heel of the wall is tied into an egg-shaped drain. The vertical section of the wall is 18″ thick. The foundation extends 2′ in front, and in the higher sections, 9′ in back of the face of the wall

The wall is reinforced with ⅝-in. and ¾-in. rods at various spacings. The base was constructed in 8-ft. sections because of the interference of the bracing that held the roadway in place; the wall proper was built in 48-ft. sections. After the wall had been practically completed and the slope trimmed, a slippery clay was exposed, showing that a general movement of the wall would probably follow the backfilling. A large toe pier was constructed below and in front of the base of the retaining wall and extending to rock.

Dividing Wall and Conduit.—A novel arrangement was made use of in the large dividing conduit extending across the middle of the basin. As shown in Figs. 2 and 3 it serves both as an inlet and an outlet conduit; and the incoming water finds its exit into the reservoir through lateral distributing conduits.

The combined dividing wall and conduit consists of a triangular conduit of an area equivalent to a 7-ft. circle, supported on two legs or cut-off walls extending from 5′ to 9′ below the floor to bed rock, all surmounted by an 18-in. wall about 5′ high, making the height of the conduit wall 16′ above one basin floor and 18′ above the other. The sides of the triangular conduit are 20″ thick, reinforced with 7/8-in. and 1/2-in. bars as shown in Fig. 3. The base of the triangle is designed as a beam, with the same reinforcement as the sides. The surmounting wall is designed as a cantilever.

A very effective method of reinforcement was utilized in the construction of this dividing wall, as shown in Fig. 3. The hooks at each end of the 14-ft. bars in the base give an added strength and rigidity not possible to obtain by the ordinary methods of doing this work.

From the main gate house to this conduit wall, the inlet conduit consists of a 7-ft. circular reinforced concrete conduit.

Distributing Conduits.—The dis-section of this conduit is in the form tributing conduits, which extend along the southerly slopes of both basins, were built of concrete. A of a trapezoid, the top of which is horizontal, the bottom of which is the upper layer of the floor system on the 2:1 slope, and the sides of which are vertical. Circular openings are provided in the top of the conduit, to provide for circulation of water near the secondary gate house.

Reservoir Lining.—The lining of the reservoir floor and of the slopes up to the revetment consists of two 4-in. layers of concrete, as shown in Fig. 4, the joints overlapping 8″, instead of the usual method of overlapping from center to center of blocks. The lining of the slopes above the revetment drain consists of a 4-in. layer of concrete covered to a depth of 12″ with large gravel, upon which rest a 6-in. layer of reinforced concrete, the waterproofing and a 4-in. surface layer of concrete. The floor blocks are 10′ x 10′, while the blocks on the slopes vary from 8′ x 10′ to 16′ x 38′, the larger blocks being in the 6-in. reinforced layer.

Waterproofing of the slopes consists of four 1/16-in. layers of Sun asphalt and three layers of 8-oz. saturated burlap,[1] laid alternately, between the layers of concrete, while in the floors three layers of asphalt and two layers of burlap in 18-in. strips were used at the floor joints only in such a manner that the waterproofing overlaps the joints of both layers by 5″. All joints were treated with asphalt either by mopping or by pouring the spaces left by the 1/4-in. steel plates used as forms. The three-ply waterproofing is about 3/8-in. thick, while the two-ply waterproofing is about 1/4″ thick.

Supply Main.—The supply main is a 60-in. steel riveted pipe, extending from the city filtration beds at Aspinwall, two mi. up the Allegheny river from the Cabbage Hill basin, the water entering the basin through

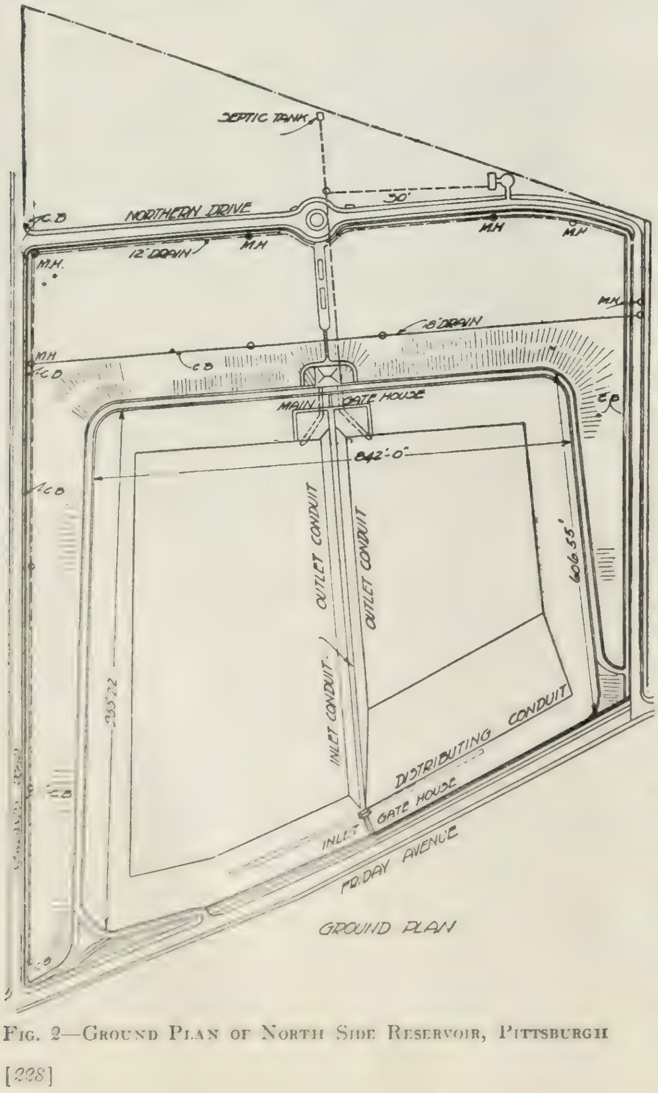


Fig. 2—Ground Plan of North Side Reservoir, Pittsburgh

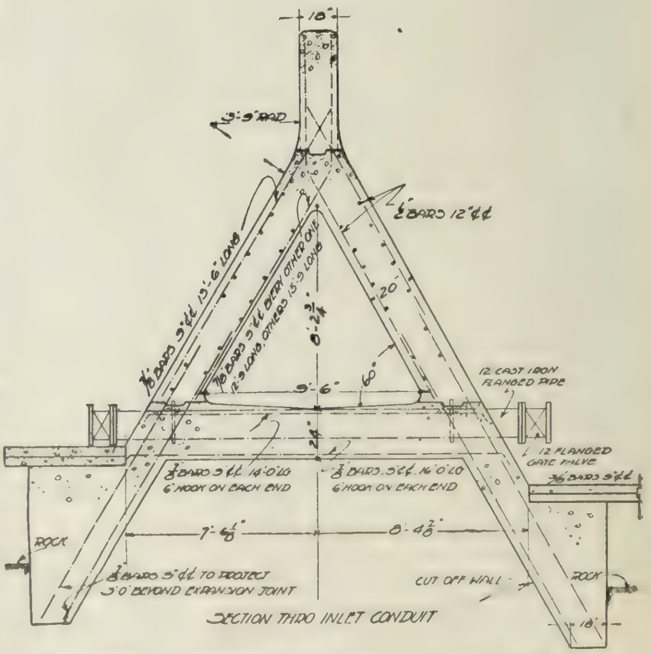

18"
3'-9" RAD
1/2" BARS 12" c.c.
7/8" BARS 9" c.c. 13'-6" LONG
7/8" BARS 9" c.c. EVERY OTHER ONE 12'-9" LONG, OTHERS 15'-9" LONG
20"
8'-2 1/4"
60°
9'-6"
12" CAST IRON FLANGED PIPE
12" FLANGED GATE VALVE
24"
7/8" BARS 9" c.c. 14'-0" LG 6" HOOK ON EACH END
7/8" BARS 9" c.c. 16'-0" LG 6" HOOK ON EACH END
3/8" BARS 9" c.c.
7'-6 1/8"
8'-4 7/8"
ROCK
7/8" BARS 9" c.c. TO PROJECT 3'-0" BEYOND EXPANSION JOINT
CUT OFF WALL
ROCK
18"
SECTION THRO INLET CONDUIT

Fig. 3 - Section Through Inlet Conduit, North Side Reservoir, Pittsburgh

a 60-in. reinforced concrete conduit at the north side, and at the bottom of the reservoir. About 2,000 lin. ft. of this steel pipe was used on the work.

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[1] The Lehon Co., Chicago

Sluice-Gates.—Both the influent and the effluent conduits are controlled from the same gate-chamber at a single gate house. The sluice gates are of the standard cast-iron type, the gate-gears being operated from a motor-driven line of shafting attached to the chamber walls. Four of the six larger gates are thus operated, the other two being worked by hand. These six sluice-gates are 3′ 6″ x 6′ in dimensions. There are also two gates 2′ 6″ x 3′, two of 60″, two of 48″, two of 12″, eight of 8″, and six of 6″. There are two 6-in. and 12 12-in. check valves and two Venturi meters of the 60-in. type.

About 6,050′ of agricultural tile pipe was used, including 6-in., 8-in., 12-in. and 18-in. sizes, mostly utilized in ground-water drains, where gravel was also made use of.

There are four inspection wells on each side of the reservoir.

MATERIALS OF CONSTRUCTION

Universal Portland cement[2] was used throughout the work. The coarse river gravel varied in size from ½″ to 2½″. The chief,—in fact, the only—difficulty the contractor was called on to overcome was in the transportation of material. Seventy thousand tons of sand, gravel and cement had to be hauled 1¾ mi., the last ¾ mi. of which was up a grade exceeding 6%, the road being, moreover, an indifferent one. It led from Ohio St., a paved thoroughfare parallel to and near the Allegheny river, to the site of the reservoir. The handling of this enormous amount of material was effected with the greatest efficiency and dispatch.

All of the sand and gravel used in the construction of the reservoir was dug from the Allegheny river in the vicinity of Hoboken, from which point it was transported in barges to Millvale, where the contractor had installed a hoisting plant. The material was taken from the barge in a clamshell bucket and dumped into an elevated storage bin containing compartments for coarse gravel. fine gravel and sand. From this bin it was taken to the reservoir, a distance of 1¾ mi., by a group of six 5-ton Pierce-Arrow auto trucks[3] equipped with Goodrich wireless tires,[4] each truck making from 18 trips to 20 trips per da. of 11 hrs.

The cement was received at a siding adjacent to the Millvale storage bin, and transported to the reservoir in a 5-ton flat-bed truck. Throughout the summer of 1914 these trucks were operated on double shift, or 22 hrs. per da., in order to maintain a supply of materials at the reservoir site. From the fleet of seven trucks, it was found necessary to hold one truck each day in the company's own repair shop for overhauling, oiling, etc.

Each truck averaged 24 trips a day, the round trip consuming about 45 mins.

Reinforcement.—The reinforcing bars are of the square twisted type, made from open-hearth steel, with a tensile strength before twisting of not less than 55,000 lbs. nor more than 70,000 lbs. per sq. in.

Waterproofing.—There are two layers of concrete on the slopes and the floor of the reservoir, each 4″ thick, with three-ply open-mesh Manila burlap between, the burlap being saturated in a bath of heated asphalt. The specifications provided that this burlap must contain 99.5% pure bitumen, and that it weigh not less than 8 oz. per lin. ft., 40-in. middle width, before saturation, nor more than 16 oz. after saturation.

EXCAVATION AND EMBANKMENT.

Work of clearing the site was started July 20, 1912. Preparatory to embankment work, the entire site of 24 acres was cleared of all vegetable growth and the top soil removed to storage piles. Good foundation for embankment was found in most places at a depth of about 18″.

All embankment material was obtained from excavation in the basin and consisted mainly of first-class clay of several shades, and of easily broken shale, though in some cases low-grade dynamite was used to facilitate digging. Most of this shale disintegrated rapidly when exposed to the atmosphere. A mixture of the clay and shale was spread in layers of 6″ or less, and rolled with Buffalo-Pitts grooved rollers[5] weighing 2 tons per ft., producing a very hard, impervious embankment. It was necessary to pass the roller over each layer at least six times to compact the soil thoroughly and to break up the small stones. No stones larger than 4″ in diameter were placed in the embankment.

The total amount of excavation was about 350,000 cu. yds., including 13,000 cu. yds. of top soil excavating and embankment. To build the embankments required about 281,000 cu. yds. The general filling represented about 1,000 cu. yds.

Test pits sunk by the engineers of the Water Bureau revealed the presence of rock, but not in any considerable quantity.

Three steam shovels, a Marion,[6] a Bucyrus[7] and a Thew,[8] with a 3-yd. 1½-yd. and ½-yd. dippers and a 70-ton McMyler Interstate locomotive crane[9] were used in excavating, the larger shovels working efficiently in the shale. Four Porter contractors' locomotives[10] and 50 Koppel dump cars,[11] of 4 cu. yds. capacity, were used in conveying the material to the embankments.

An engine-operated spreader, two road graders and four 16-ton rollers were used in spreading and rolling the embankments.

The maximum yardage excavated and rolled in embankment in one da. of 11½ hrs., was 3,500 cu. yds.

THE FORMS

Steel forms were used for the main drain and for an egg-shaped drain along the roadway. Forms for the dividing wall and conduit were handled by the Lidgerwood cableway, to be described in connection with the central concrete plant.

CONCRETE WORK

Proportions.—All concrete used in the construction of the reservoir was of 1:2:4 mix, except in small work, such as manholes, catch-basins and gate vaults.

Mixing.—Concrete for the main gate house foundation was mixed in an electrically operated Ransome 1-yd. batch mixer,[12] all materials being handled by the traveling crane. An electrically operated 1½-yd. Ransome mixer was installed on the secondary gate house foundation directly in front of the storage bins. Concrete for the retaining wall and the toe pier was mixed in a ½-yd. Ransome mixer, as well as that used in the dividing wall and conduit.

Especially noteworthy was the concrete-mixing plant, shown in Fig. 5. It proved one of the most efficient of any ever constructed on a job in the Pittsburgh district. It was built on the inside wall of the basin, or on the Friday St. side. The gravel and cement were placed on separate floors, the cement being on the upper. By means of levers on the charging floor the gravel, sand and

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[2] Universal Portland Cement Co., Chicago
[3] Pierce-Arrow Motor Car Co., Buffalo, N. Y.
[4] B. F. Goodrich Co., Akron, Ohio

[5] Buffalo Steam Roller Co., Buffalo

[6] Marion Steam Shovel Co., Marion, Ohio
[7] Bucyrus Co., So. Milwaukee
[8] Thew Automatic Shovel Co., Lorain, Ohio
[9] McMyler Mfg. Co., Cleveland
[10] H. K. Porter Co., Pittsburgh
[11] Orenstein-Arthur Koppel Co., Koppel, Pa.
[12] Ransome Concrete Mchy. Co., Dunellen, N. J.

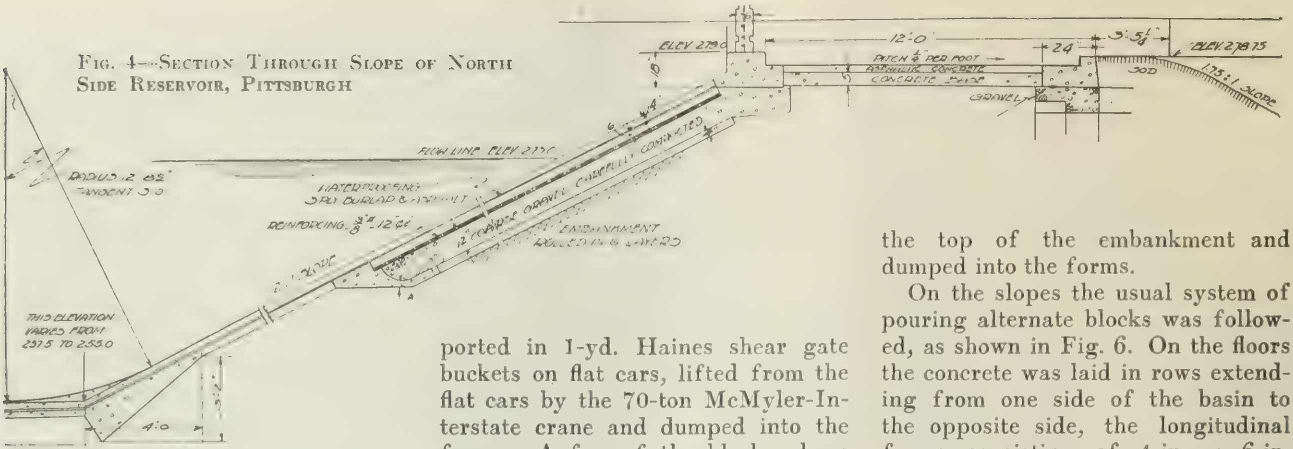

Fig. 4—Section Through Slope of North Side Reservoir, Pittsburgh

cement were slid into the mixer by gravity, a No. 40 Ransome mixer, of 40 cu. ft. loose capacity, and electrically driven, was used. The gravel storage bin had a capacity of 500 cu. yds.; that of the sand bin, 250 cu. yds.

The sand and gravel from the bins were controlled by shear gates directly above th emixer hopper, while the cement was placed in a vertical chute directly over the hopper, and controlled by a slide gate. The hopper was standardized for 1 yd. of concrete.

During the busy season 1 yd. of concrete could be turned out of the mixer every min., although the average time of mixing was about 1½ min.; this was for wet concrete used in walls and all flat work. The dry concrete used on slopes required about 2¼ min. for mixing each batch.

Conveyors.—The mixer discharged directly into Haines shear gate buckets on Kilbourne & Jacobs flat cars,[13] or to Koppel cradle cars. Three Porter locomotives were fequired during the time of the laying of the floor and slope blocks to transport the concrete from the mixer to the crane.

A Lidgerwood stationary cableway[14] was held in the construction of the dividing wall and conduit, and the well in the northerly embankment, also for general transportation purposes from Friday Ave., including the transportation of the steel reinforcement and concrete forms. The head tower is 50′ high, located on the southerly side of Friday Ave., and the tail tower is 45′ high, located on the gate house in the northerly embankment. The distance between towers is approximately 850′.

Placing Concrete.—All concrete used below the revetment was mixed at the central mixing plant, transported in 1-yd. Haines shear gate buckets on flat cars, lifted from the flat cars by the 70-ton McMyler-Interstate crane and dumped into the forms. A few of the blocks above the revetment were placed in this same manner; a few such blocks were also built from concrete mixed in a ½-yd. mixer on top of the embankment, dumping directly into forms; but the major portion of these blocks were built from concrete mixed at the central plant, conveyed in 1-yd. Koppel cradle cars along the top of the embankment and dumped into the forms.

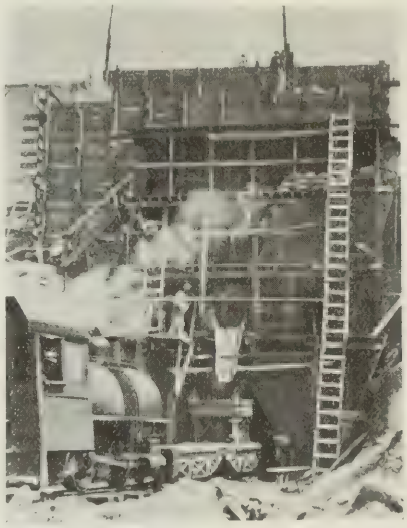

Fig. 5—Contractor's Plant—Concrete Mixer, Storage Bins, Etc., Built on Inside Wall on Friday St. Side, North Side Reservoir, Pittsburgh

On the slopes the usual system of pouring alternate blocks was followed, as shown in Fig. 6. On the floors the concrete was laid in rows extending from one side of the basin to the opposite side, the longitudinal forms consisting of 4-in. x 6-in. stringers, while the transverse forms were ¼-in. x 4-in. steel plates set in the stringers and the points of the preceding row of blocks. The concrete was finished with straightedge and wooden trowels. (See Fig. 7.)

In a day of 11 hrs., 488 yds. of concrete were placed in floor blocks and finished. An average of 375 yds. per da. was maintained for a period of 4 wks.

For its magnitude, it is claimed that this was one of the fastest jobs of concrete lining in the U. S. This was made possible largely through unusually favorably weather conditions, the number of rainy days on which operations could not be carried on being very small.

Concrete for the main gate house foundation was poured in two horizontal sections and five vertical sections. The main drain and the egg-shaped drain along the roadway were both poured in two sections, except where the main drain was reinforced, near the gate house. Concrete in these drains was mostly hand-mixed. The greater part of this work was done in cold weather, making it necessary to heat the materials and maintain fires in the trenches.

The base of the reinforced concrete retaining wall was constructed in 8-ft. sections because of the in-

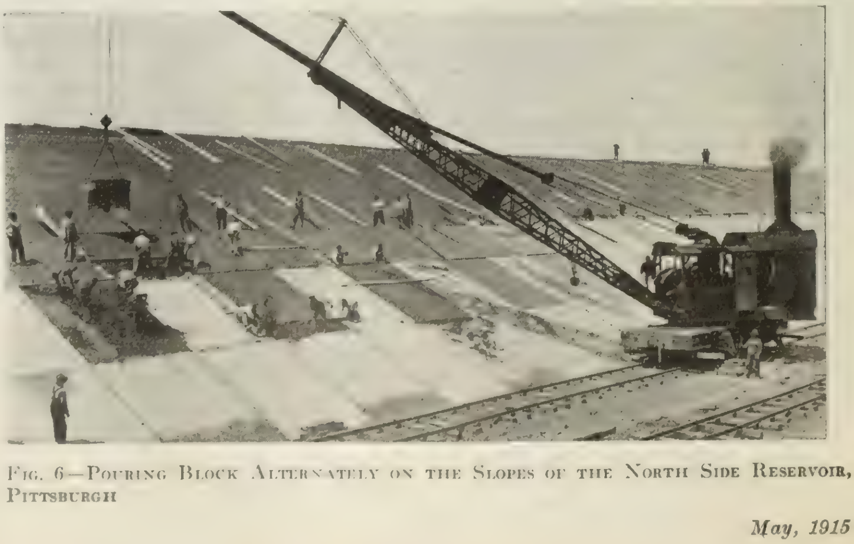

Fig. 6—Pouring Block Alternately on the Slopes of the North Side Reservoir, Pittsburgh

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[13] Kilbourne & Jacobs Mfg. Co., Columbus, Ohio

[14] Lidgerwood Mfg. Co., 96 Liberty St., N. Y. C.

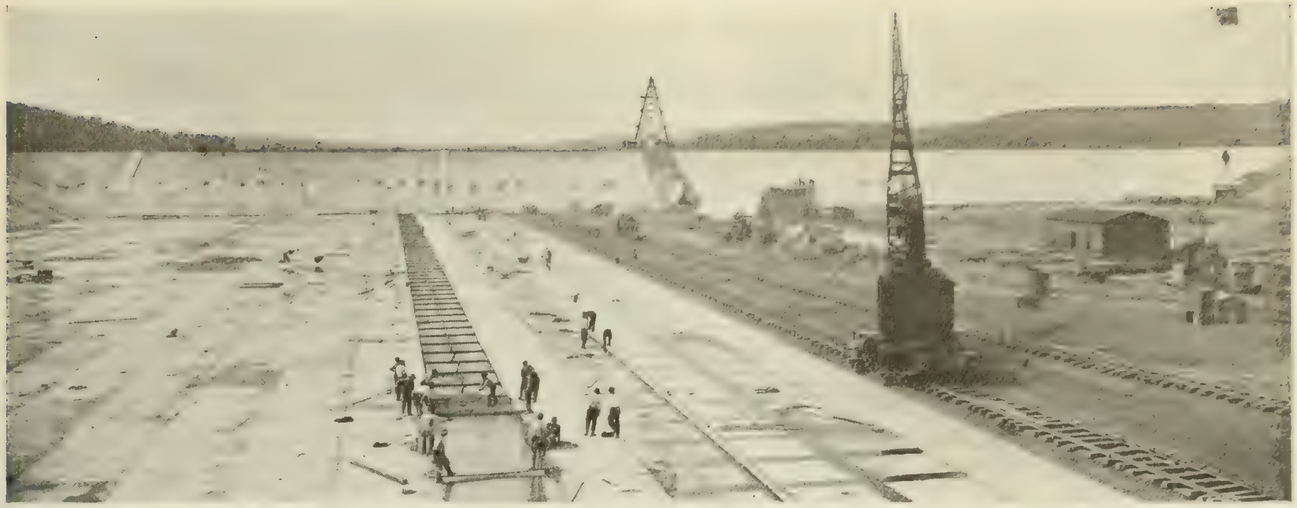

FIG. 7—CONCRETING FLOOR SLABS, NORTH SIDE RESERVOIR, PITTSBURGH

terference of the bracing that held the roadway in place; the wall proper was built in 48-ft. sections.

The dividing wall and conduit was built in 58-ft. 6-in. sections, the legs, the conduit floor and the sides with the surmounting wall being built at separate pourings. As it was practically impossible to work the concrete in the forms, two air hammers were kept constantly but gently hammering the forms during the pouring, resulting in a thoroughly compacted concrete of smooth finish.

WATERPROOFING

One of the most interesting points discovered in the course of the construction work was in relation to the waterproofing. Three plies of saturated burlap were mopped on with hot asphalt. The specifications said "all surfaces receiving waterproofing shall be clean, dry and smooth." The word "dry" in relation to setting concrete was subject to the decision of the inspectors and naturally was an open point for argument, as in order to keep the work moving, the contractors desired to lay the waterproofing as soon as possible, while the inspectors held out for strictly dry surfaces. There was an occasion to remove one of the top blocks and it was found that while the layer of waterproofing which had been mopped on to the 24-hr. old concrete had no adhesion to it at all, the top block which has been poured wet on to the asphalt could not be separated from it. Several experiments were then made and it was found that the best bond between the asphalt and concrete was obtained when the asphalt was mopped on as soon as the concrete had set so that it could be walked on without injury. The theory advanced is that as soon as concrete starts to set, it starts to "dust" and that applying the asphalt practically before this starts avoids the thin layer of dust which it is impossible to remove and which prevents the close adhesion of asphalt to concrete.

The asphalt was heated to 400° F. and applied with ordinary cotton mops. In three-ply waterproofing the burlap was lapped 13″, the width of burlap being 39″.

GENERAL FEATURES

About 206,000 cu. yds. of concrete was used in the job, the unit cost ranging from $5.80 for concrete in the floors to $12 for the concrete in conduits and drains. About 23,000 lin. ft. of concrete was used in fences, curbing, coping, etc.

The surface coating on the concrete consists of ½-in. mortar (1 part cement to 2 parts sand), troweled to a smooth surface. The joints dividing the basin slopes and floors are filled with asphalt, $\frac{1}{16}$″ in thickness. The corners of the reservoir are curved, imparting a graceful appearance as shown in Fig.

The concrete fence surmounting the top of the basin and built at the edge of the slope, adds an artistic touch to the great reservoir. It is 32″ high and 6″ thick. The posts were poured first, corrugated paper being used in connection with the expansion joints.

PERSONNEL

The reservoir and appurtenances were designed by and constructed under the supervision of the Bureau of Water, which is under the jurisdiction of the Public Works Dept. The work was done by the John F. Casey Co., Pittsburgh, the contract having been let to it July 16, 1912, for $683,976.

Does Russia Want Canadian Cement?

In olden days a current characterization in the newspaper editorial offices was "important, if true." In a recent issue of the New York *American*, the following heading appears: "Russia Balked in Huge Canada Cement Deal" and following in smaller type is a statement that "Russia is trying to buy 1,000,000 bbls. of cement in Canada, but the order cannot be filled because of the lack of ocean transportation facilities." To those familiar with the cement industry it is difficult to see why Russia, which possesses a great number of cement works of her own and large supplies of coal, cement-making materials and labor, should be seeking to buy cement in Canada and even when she could buy it, how she would transport it to the front. Cement is not a vest-pocket commodity and freight is an important factor and by the time 1,000,000 bbls. of Canadian cement had been transported across the Pacific, across the Trans-Siberian Railroad and across the continent of Europe, it would seem that the value of the cement would be very insignificant as compared with the freight paid. It is true that the difficulty of obtaining coal and an insufficiency of labor have had the effect of lessening the cement production in England as the fuel is transported from the north to London through the English Channel, but there is no interruption to the manufacture of cement in France and Russian works, as already stated, have abundant home supplies and all the necessities for the production of Portland cement.

Tests of Circular and Egg-Shaped Concrete Sewer Pipe for the City of Philadelphia[1]

By Albert T. Goldbeck[2]

The pipes were reinforced with triangular mesh placed 1¼″ from the inner surface is follows:

	Used in 24-in. x 36-in. egg-shape	Used in 36-in. circle
Number of strands, longitudinal	1	2
Gauge of longitudinal strands	6	8
Gauge of cross-wires	12½	12½
Sectional area, long. sq. in.	0.087	0.124
Sectional area, cross-wires sq. in.	0.038	0.124
Cross-sect. area, cross-wires sq. in.	0.110	0.146
Wt. per 100 sq. ft.	50 lbs.	63 lbs.
Tensile strength	80,000 lbs. to 90,000 lbs. per sq. in.	

CURING PIPES

After pouring in special steel molds, the pipes were allowed to harden, some of them under atmospheric conditions, others when subjected to a hot vapor bath continued for a period of about 12 hrs. The application of hot vapor at a temperature of about 100° F., accelerates the hardening and permits the removal of the forms on the day after pouring without danger of injury to the pipe during the removal. It thus permits the manufacturer to economize on molds. It likewise enables him to make pipes in freezing weather. After the molds were stripped the green concrete was kept damp by daily sprinkling for 1 wk.

EXTERNAL LOADING TESTS

Method of Bedding.—Two methods of bedding the pipes were employed, (a) damp sand bedding and (b) bedding in a concrete cradle, as shown in Fig. 1. Three ins. of sand or concrete was used under the pipes extending on each side to a height of ¼ of the vertical diameter. Where a sand bedding was used, the pipe was placed on the layer of lightly tamped sand and sand was heaped and tamped around the sides to the proper height. In the case of the concrete cradle bedding, the pipe was placed in the soft concrete and it remained there until tested. In some cases the cradle was only 1 da. old when the pipe was tested, but generally was older than this.

The specifications under which the pipes were laid called for a concrete cradle such as described, but the sand bedding tests were made in order to inquire into the necessity for the concrete cradle construction.

Method of Loading.—The load was transmitted to the specimen under test through a cushion of dampened sand, contained in a bottomless box resting on the specimen. The box was properly braced with tie-rods to prevent its spreading under load. A wooden plunger, carrying a timber platform, rested on the sand, and the load was obtained by piling bags of cement on the platform. This method was adopted in the absence of a testing machine of the desired type and capacity. It was a very expensive method, but was quite effective. The loads were applied at the rate of 10 bags (950 lbs.) in about 5 mins. and vertical distortion readings were taken after each 10-bag increment. Figs. 1 and 2 show in detail the method of loading.

Method of Measuring Vertical Distortion.—In order to note the elastic behavior of the pipes under load, distortions of the vertical diameter and in some cases distortions of the horizontal diameter were measured. This was done in two ways (1) by the use of an Ames dial reading to 0.001 in. and (2) by the measurement of the middle ordinate between two light wooden battens sprung into place between the crown and the invert. A very slight movement in vertical distortion produces a comparatively large increase in the middle ordinate. This device is extremely cheap and convenient to attach. It is held in place entirely by the compression on the battens. The middle ordinate readings were taken on a scale reading to 0.01 in. and were readily converted to vertical deflection by calibration. This device was used merely as an expedient during the temporary lack of an Ames dial. It, however, is quite accurate and is capable of refined application in other fields of testing where deflection measurements must be made.

THE TESTS

It was the aim to test a single pipe of each kind at the ages of 7 das., 14 das., 21 das. and 28 das., bedded in sand and concrete and cured with and without steam, and this program was followed as completely as weather and other conditions would permit. The pipes were placed in their cradle at least 1 da. before testing. Vertical distortion readings

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[2] Asst. Engr., Bur. of Surv., Philadelphia

[1] Slightly condensed from a paper presented before the 11th Annual Convention of the Am. Concrete Inst.

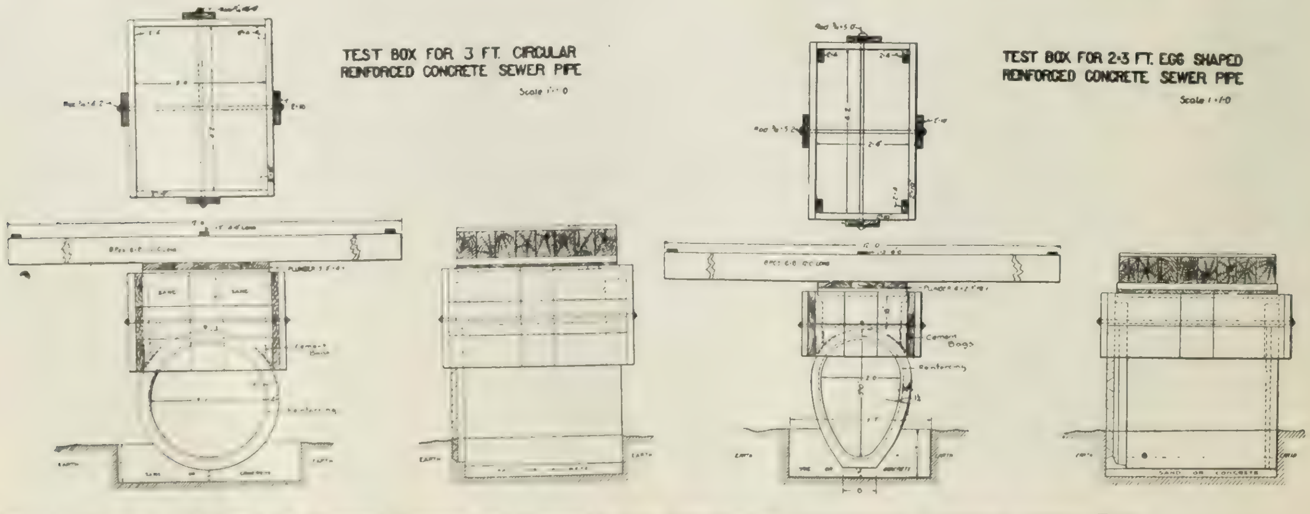

TEST BOX FOR 3 FT. CIRCULAR
REINFORCED CONCRETE SEWER PIPE
Scale 1"=1'0"
TEST BOX FOR 2-3 FT. EGG SHAPED
REINFORCED CONCRETE SEWER PIPE
Scale 1"=1'0"
SAND
Cement Bags
Reinforcing
EARTH
SAND OR CONCRETE

Fig. 1—Plan and Section of Testing Devices for Circular and Egg-Shaped Reinforced Concrete Sewer Pipe

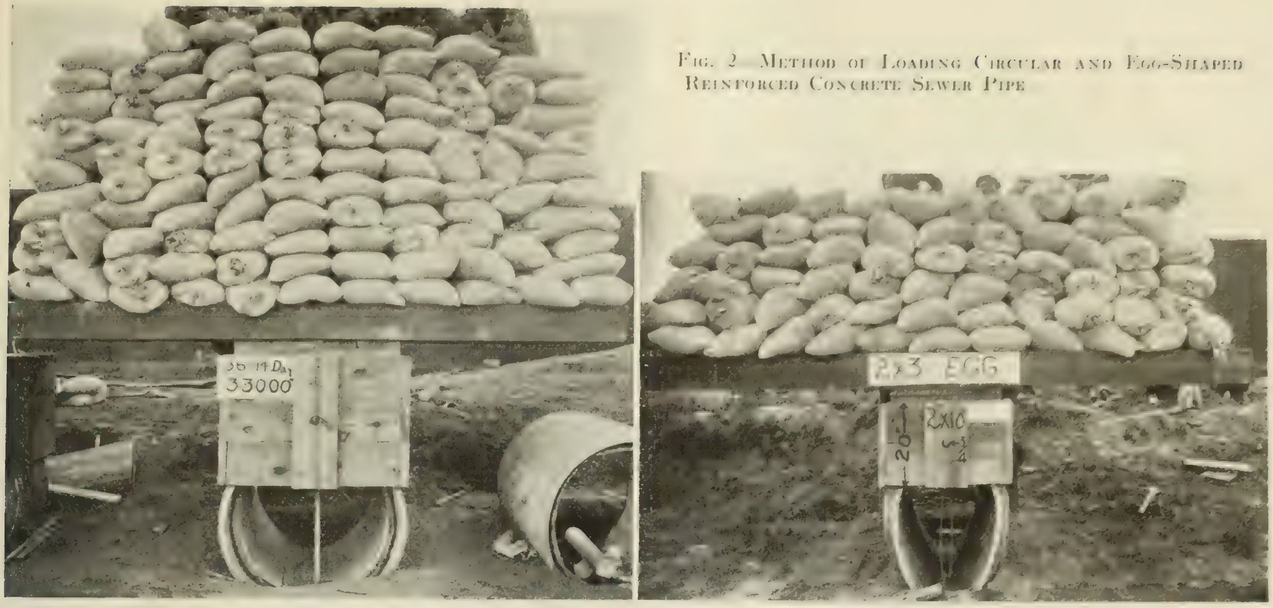


Fig. 2 Method of Loading Circular and Egg-Shaped Reinforced Concrete Sewer Pipe

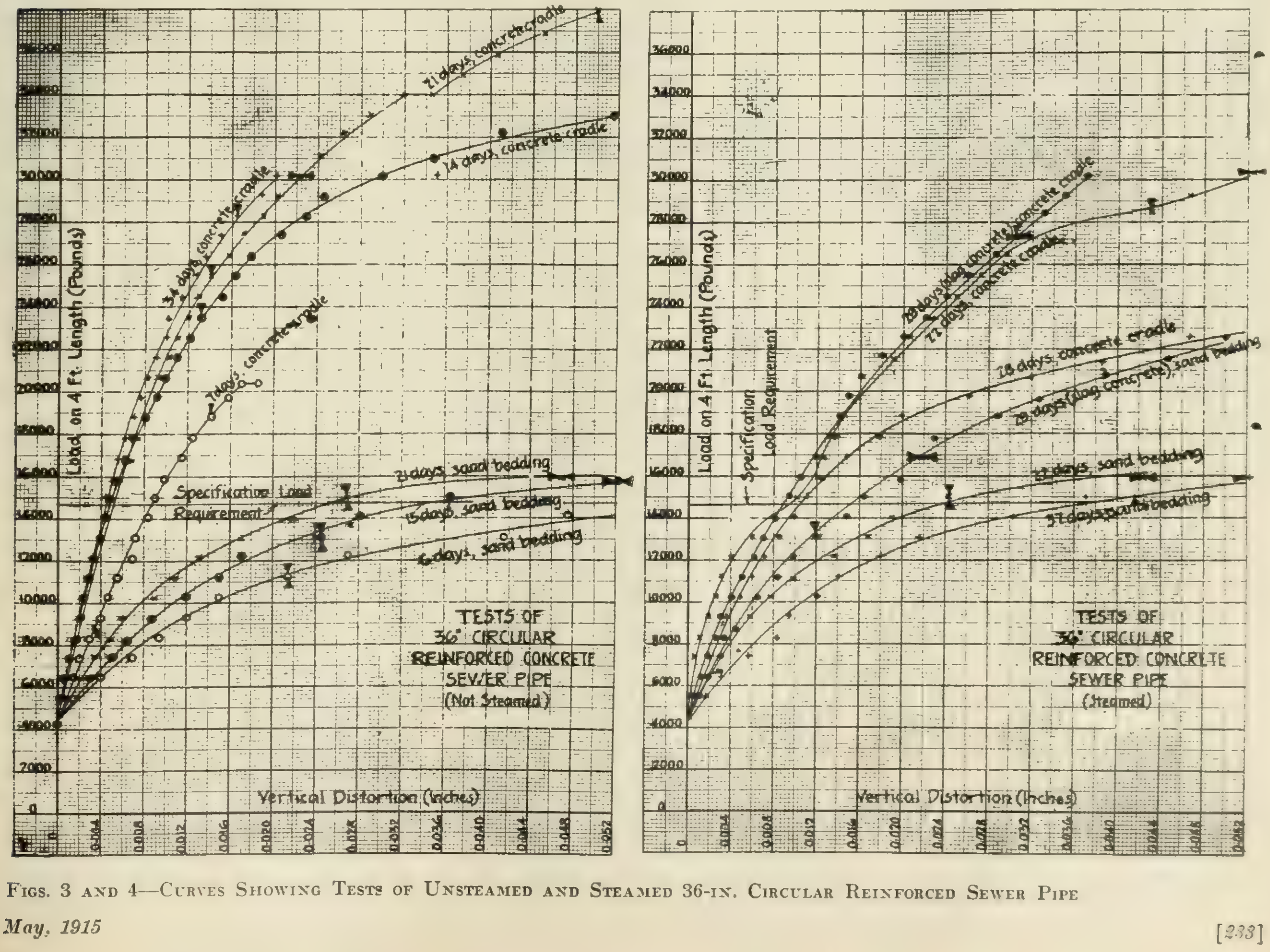
were not taken until the sand-box and the loading platform were mounted into place, and the initial readings were made under the weight of sand-box and platform loading.

After each increment of 950 lbs., distortions were read, and the surface carefully searched for hair-cracks.

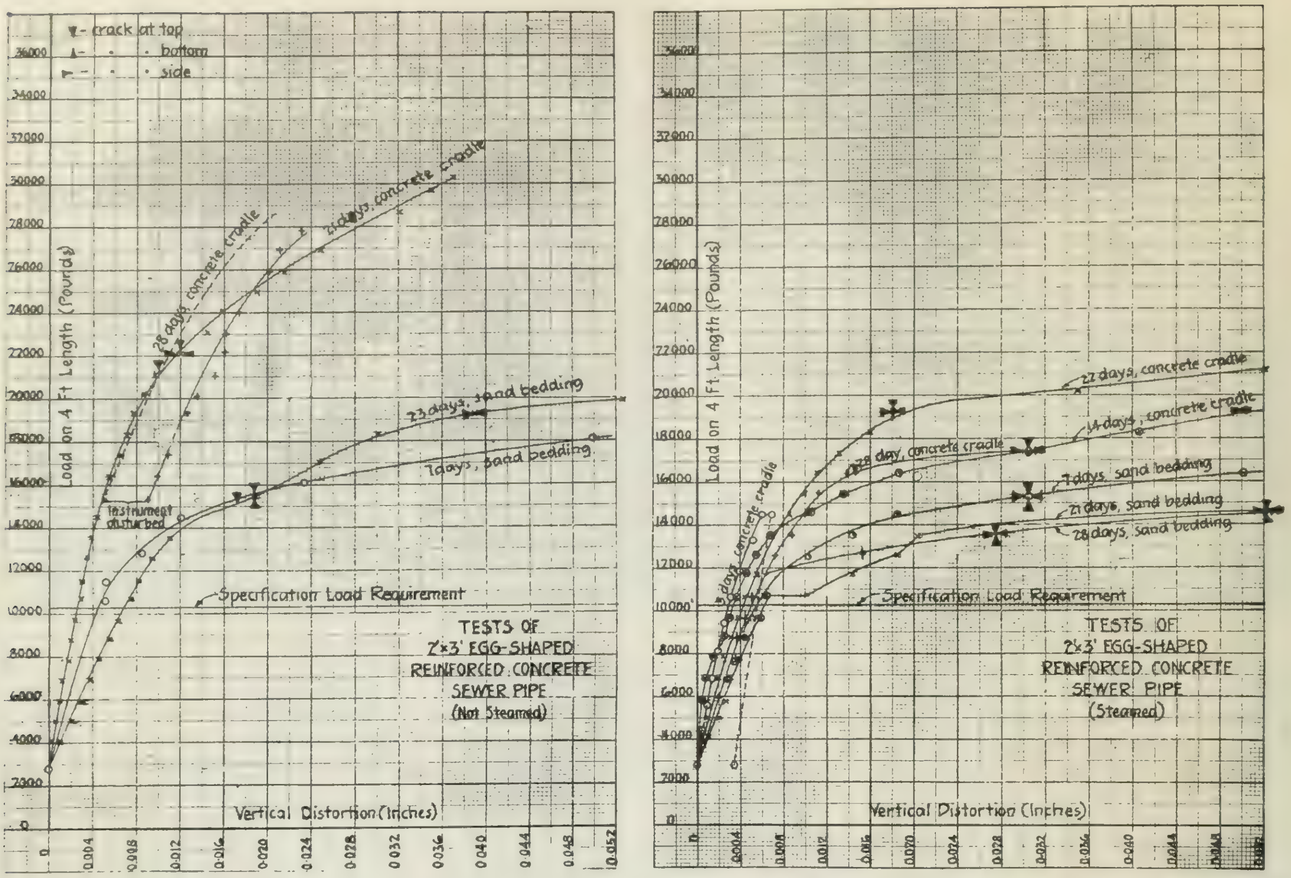
CURVES OF VERTICAL DISTORTION

The readings for vertical distortion are plotted as abscissae in Figs. 3, 4, 5 and 6, and the ordinates are the corresponding loads carried on the test section of pipe, 4′ long. The curves thus obtained indicate several facts concerning the pipes:

Considering first the unsteamed pipes, it will be seen that stiffness is gained with age, and the load under which the first hair-cracks became visible likewise advances with the age of the pipe. This is to be expected, and is in agreement with other tests on reinforced concrete. Note the great increase in stiffness resulting from the use of a concrete cradle rather than sand bedding. As an accompanying result, cracking occurs at a much higher load when a concrete cradle is used than where the pipe is merely bedded in sand. This is true of egg-shaped and of circular sections, but is particularly true of the circular pipes. It was required by the city specications that the pipes be able to withstand an external load of 1,000 lbs. per sq. ft. without showing cracks. This was a reasonable require-



Figs. 3 and 4—Curves Showing Tests of Unsteamed and Steamed 36-in. Circular Reinforced Sewer Pipe



Figs. 5 and 6—Curves Showing Tests of Unsteamed and Steamed 24-in. x 36-in. Egg-Shaped Reinforced Concrete Sewer Pipe

ment for the conditions under which the pipes were laid. It will be noted that the circular sections embedded in sand when unsteamed are unable to pass the specifications at 6 das. and 15 das. and lie uncomfortably close to the requirements at 21 das. When a concrete cradle is used, however, no difficulty whatever is encountered in exceeding the loading requirements. In constructing a sewer of circular pipes such as these, with a likelihood of their being subjected to a load of 1,000 lbs. per sq. ft., a concrete cradle, extending in height ¼ of the diameter of the pipe above the base is recommended as necessary in order to avoid cracks.

As might be expected, the egg-shaped pipes were stiffer than the circular pipes, and were not afforded so much extra support by the concrete base as were the circular pipes. However, even in the egg-shaped sections, the extra stiffness and resistance against cracking provided by the concrete warrant its use.

A comparison of the steamed and the unsteamed pipes is of interest. There seems to be an indication that the steam-cured pipes, that have had their setting accelerated, are more uncertain in their strength at the later periods than are the pipes cured under normal conditions. The strength of the normally cured pipes follows a fairly definite law of increase in stiffness with age. The steam-cured pipes on the other hand are extremely erratic, some of the older pipes exhibiting less stiffness than those of lesser age. The steam method of initial curing is open to some question, and if allowed, should be very carefully controlled in order not to drive out the moisture from the concrete before the cement has attained its set.

The behavior of the experimental pipes made with blast furnace slag as coarse aggregate is interesting in indicating that the strength and stiffness of the pipes of this material equaled or even slightly exceeded those of pipes made with crushed trap.

HAIR-CRACKS

It is highly undesirable to subject a reinforced concrete sewer pipe to a load such that hair-cracks are likely to form, because of the danger of corrosion of the reinforcing metal that must result. That load which causes a visible hair-circle to form is, therefore, to be regarded as the ultimate strength of the pipe, even though the load necessary to cause actual collapse may be much higher.

On the curves, the loads at which cracks were first noticed are indicated by arrowheads, and the position of the arrow indicates the position of the cracks, whether at the bottom, top or sides of the pipes. The pipes embedded in sand almost invariably failed by cracking at the bottom, inner surface or invert, and in the circular pipes a crack was generally first noticed at the top inner face. The side cracks which occurred on the outer surface of the sand-embedded pipes were sometimes noticed simultaneously with the top and the bottom cracks, and sometimes not until after the top and the bottom cracks had formed.

When a concrete cradle is used, the first crack almost invariably occurs at the top, and is sometimes accompanied by side cracking on the outside. Cracks do not form at the extreme bottom when the pipe is bedded in concrete, although under very high loads, and after all other cracks have formed at the top and sides, inside cracks will develop just above the level of the concrete cradle.

A very green concrete cradle, even when not more than 1 da. old, adds greatly to the strength of the pipe.

The order of formation and the position of the cracks are very comforting, particularly when a concrete cradle is used. Thus it has been seen that the invert remains intact even long after the pipe has been loaded sufficiently to crack it at the crown. The sand-bedded pipes, however, cracked at the invert under quite a low load. This is an additional argument for the use of a concrete cradle rather than earth bedding. The fact that cracking occurs at the top or the bottom on the inner surface before it occurs at the sides on the outer surface is significant. It shows that the steel is correctly placed to provide for the tension at the dangerous sections of the pipe. Increased resistance against complete collapse would perhaps be obtained by shaping the steel to approach the outer surface at the sides, but collapsing strength is not of much interest as it is well above the load required to produce the first visible crack. The extra expense which would be involved in this procedure is therefore not warranted.

TESTS FOR IMPERMEABILITY AND RESISTANCE AGAINST INTERNAL PRESSURE

In a sewer of the size tested, a leakage amounting to more than about 10,000 gals. per mi. in 24 hrs. might well be regarded as the maximum allowable limit. A reasonably tight sewer placed in the wettest soil at a considerable depth should not admit more than this amount of ground

water. Not only should the sewer be safe against excessive inward leakage but it should likewise be capable of resisting a possible interior pressure due to flooding without cracking and thereby developing large leaks.

The specifications required, therefore, that excessive leakage should not occur under a pressure of 5 lbs. per sq. in. and should not crack nor burst under a pressure of 10 lbs. per sq. in. interior pressure.

In order to make the hydraulic test, two sections of pipe were grouted together in the same manner in which they would be treated in the trench. Heads made of steel plates were bolted to the ends by means of long bolts extending through the pipe and along the sides. Rubber carriage tires of the correct diameter were used as gaskets to prevent leakage at the ends. The leakage was collected in a tin drip-pan and measured. The grouted joint connecting the two sections was about two wks. old when the first test was made, and the pipes were 30 das. old.

TABLE I—RESULTS OF TESTS ON REINFORCED CONCRETE SEWER PIPE 4' LONG

Pipes steamed at about 100° F. for 12 hrs. before removal from forms.
24-in. x 36-in. Egg-shaped Pipes

How supported	Age das.	Load at first crack	Vertical distortion at first crack	Total load applied. No collapse	Vertical distribution	Position of first crack
Concrete cradle	3	......	.....	14,500	0.008	No cracks observed
Concrete cradle	14	21,150	0.029	25,950	0.08	Top
Concrete cradle	22	19,250	0.019	24,950	0.130	Top and sides
Concrete cradle	28	16,400	0.015	17,350	0.031	Top
Sand bedding	7	15,350	0.031	16,400	0.051	Top, bottom, sides
Sand bedding	14	17,350	0.034	19,250	0.05	Top, bottom, R. side
Sand bedding	21	14,500	0.06	19,250	0.214	Top, bottom, sides
Sand bedding	28	13,350	0.028	19,250	0.262	Top, bottom, sides
36-in. Circular Pipes						
Concrete cradle	22	28,300	0.043	30,250	0.053	Top
Concrete cradle	28	24,500	0.064	29,250	0.106	Top and sides
Concrete cradle	29*	27,350	0.032	30,200	0.037	Top and sides
Sand bedding	22	15,000	0.026	15,950	0.044	Top and bottom
Sand bedding	29*	13,100	0.012	23,550	0.054	Top
Sand bedding	37	15,050	0.04	20,750	0.11	Bottom
Pipes not steamed while in forms						
24-in. x 36-in. Egg-shaped Pipe						
Concrete cradle	21	22,150	0.014	30,300	0.038	Side and top
Concrete cradle	28	21,150	0.011	28,750	0.022	Top
Sand bedding	7	15,300	0.02	21,000	0.08	Bottom
Sand bedding	23	15,450	0.02	21,150	0.106	Top
36-in. Circular Pipes						
Concrete cradle	7	18,800	0.017	20,300	0.02	Top
Concrete cradle	14	23,550	0.015	33,050	0.05	Top
Concrete cradle	21	25,450	0.016	42,550	0.08	Top
Concrete cradle	34	28,300	0.016	30,200	0.03	Top and bottom
Sand bedding	6	11,200	0.028	33,000	Est. ¾"	Top and bottom
Sand bedding	15	13,100	0.028	16,900	0.067	Top
Sand bedding	21	15,000	0.03	19,750	Abt. 0.16	Top and bottom

*Slag concrete pipe

Tests on Sand Used in Concrete Sewer Pipe

Strength tests—Tension, 1:3 mortar

Sp. gravity	2.654		
% voids (loose)	42.5		
Wt. per cu. ft. (loose)	95.7		
	7 das.	28 das.	3 mos.
Bank sand	199	344	415
Ottawa sand	330	460	493
Ratio	60.3	72.7	84.3

Compressive strength 1:3 Mortar

	7 das.	28 das.
Bank sand	850	1,842
Ottawa sand	1,194	2,625
Ratio	71.1	70.2

Passing	20	82.7%
Passing	¼	99.3%
Passing	⅛	96.2%
Passing	10	93.9%
Passing	30	72.0%
Passing	40	62.8%
Passing	50	35.5%
Passing	80	9.6%
Passing	100	4.1%
Passing	200	0.5%
	Silt	0.0%

Crushing Strength Tests on Concrete.

Cylinders made from concrete used in pipe.

No.	Age	Crushing Strength.		
1	82 das.	2,260	Steamed 10 hrs., buried in ground	77 das.
2	82 das.	3,910	Steamed 10 hrs., buried in ground	77 das.
3	60 das.	2,650	Steamed 11 hrs., buried in ground	55 das.
4	60 das.	2,410	Steamed 11 hrs., buried in ground	55 das.
*5	55 das.	1,930	Steamed 10 hrs., buried in ground	50 das.
*6	55 das.	1,700	Steamed 10 hrs., buried in ground	50 das.

*Nos. 5 and 6 made of blast furnace aggregate.

Absorption Tests of Concrete Used in Pipe.

% Absorption after 48 hrs.
Stone concrete = 4.4%
Slag concrete = 6.1%

TABLE II—RESULTS OF PERMEABILITY TEST

Age das.	Pressure lbs.	Duration of Test hrs.	Leakage, gals. per mi. per 24 hrs.
30	5	1	7,920
31	5	1½	13,860
31	5	1	11,900
32	5	1	15,840
33	5	1	10,890
34	10	½	27,700
40	10	1 (muddy water)	13,860

The internal pressure required to crack the pipes was 25 lbs. per sq. in.

A corresponding test made on a slag concrete pipe showed a leakage of 5,470 gals. per mi. per 24 hrs., and required an internal pressure of 32 lbs. per sq. in. to cause rupture. Most of this leakage occurred at the grouted joint.

The above results for the stone pipe are not particularly good. Concrete as rich as that used in the manufacture of these pipes can be made practically watertight against 5 lbs. per sq. in. pressure. Most of the leakage occurred in the upper half of the pipes as molded, showing that a difference in density existed in the concrete, depending on its position in the forms. However, in the trench, leaks such as these due to somewhat porous concrete, and not to actual cracks in the concrete, would soon become filled with silt and no undue leakage should thereafter result.

CONCLUSONS

The following conclusions seem warranted:

1. Reinforced concrete pipe, when properly made and properly cured, are very satisfactory for the construction of sewers.

2. The use of a concrete cradle greatly increases the stiffness of the pipe and raises the load under which initial cracking takes place.

3. For sections of the size tested and for smaller sections, the placing of the reinforcing near the inner face throughout the entire circumference seems to be justified.

4. The matter of curing should be very carefully controlled, as much stronger pipes will result if care is taken to keep them thoroughly wet, preferably for a period of 2 wks.

The manufacture of concrete pipe is a process that can be very precisely controlled and the character of the concrete produced should be very much superior to that made in the average concrete construction. The quality of the various materials available should be very carefully investigated before use. Much can be done toward producing stronger concrete by the selection of first-class sand and coarse aggregate. But the manufacturer should not stop at merely obtaining satisfactory constituent materials; he should go further. He should find out by very simple density tests how he should combine these constituent materials in order to obtain with them concrete of the greatest density and greatest strength, for it must be emphasized that dense concrete is vitally necessary for concrete sewer construction.

The war is having the effect of raising the prices of all sorts of commodities in Germany and cement is not "backward in coming forward." The last price of the material in Hamburg was $1.55 per bbl. of 374 lbs. net, or two sacks of 187 lbs. net. This is an advance of nearly 50 cts. per bbl. and is probably due to the large consumption of the material for fortification and trench work.

Building Concrete Drops on Irrigation Canals in Western Canada

By Robert S. Stockton[1]

Some years ago the Canadian Pacific Ry. Co. received a grant of 3,000,000 acres of land lying east of Calgary, Alta., and north of the Bow River. This tract of land is known as the irrigation block and development was begun by the construction of an irrigation system for the western section. This work was completed in 1911 and is now administered by the Dept. of Natural Resources of the Canadian Pacific Ry. Co., with head offices at Calgary. A later and larger development is called the eastern section of the irrigation block and this has reached a point where lands are being sold and settlement started.

CONCRETE DROPS ON WESTERN SECTION

This article will be confined to a discussion of some features of concrete drop construction on the western section. The main canal diverts water from Bow River just east of Calgary and discharges into Chestermere Lake about 17 mi. east. From this lake, which is merely a small reservoir or balancing pool, three large canals take out, each covering in the neighborhood of 100,000 acres of irrigable land. About 1,600 mi. of ditches and canals make up the irrigation system which is designed to deliver water to each quarter-section of land containing an irrigable area. The old timber headworks have recently been replaced by an up to date, reinforced concrete structure, and a concrete weir has been built across Bow River. The weir is designed to pass the river floods without backing water in the City of Calgary and has two sections; one 555′ long with piers every 20′ that can be closed at low water periods by stop-logs, and a section 150′ long, which can be opened and closed by an hydraulically operated steel sector. The canal gates and the stop-logs are moved by electric motors and a 10-ft. depth of water can be diverted into the main canal.

The first structures were of timber and the oldest are about 10 yrs. old; these are mostly on the secondary "A" canal system. Later the secondary "B" system was built, and last the secondary "C" canal and distributory ditches. The secondary "C" system was built in the first place with concrete drops and gate structures of a substantial and permanent type.

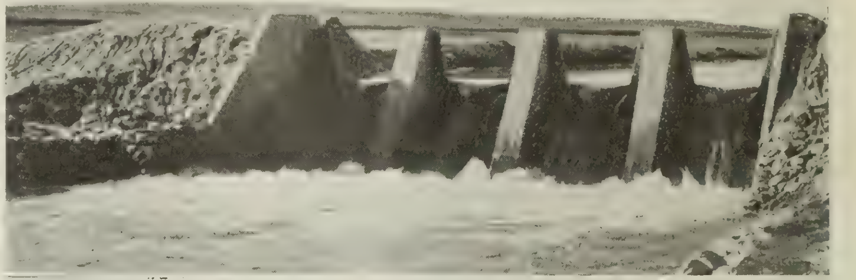


Fig. 1—Drop No. C-3 Secondary "C" Canal, Western Section, Canadian Pacific Ry. Co., Irrigation Block Near Calgary, Alta.

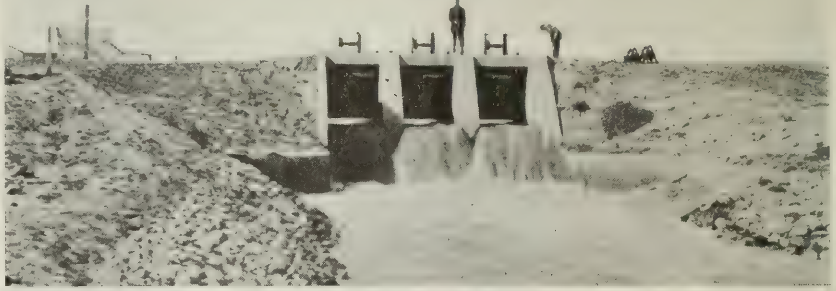


Fig. 2—Showing West Branch Secondary "C" Canal, Gates and Drop, Western Section, Near Calgary, Alta.

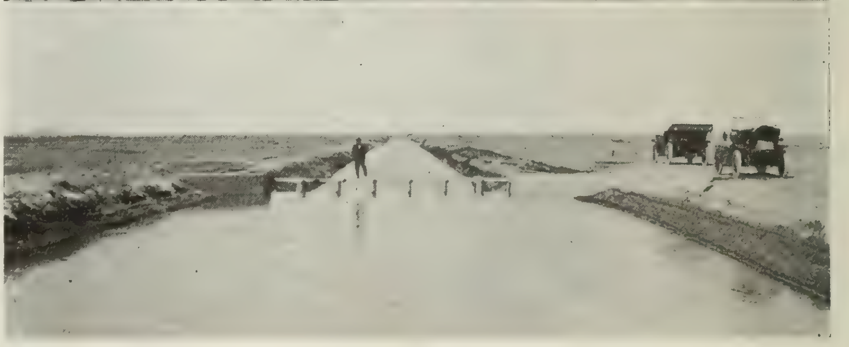


Fig. 3—Secondary "C" Canal and Hold-Up Drop C-4, Western Section, Near Calgary, Alta.

DROPS ON SECONDARY "C" CANAL

Fig. 1 shows Drop C-3 passing 283 cu. ft. of water per sec., the normal discharge for which this canal is designed being about 1,000 cu. ft. per sec. Fig. 2 shows the concrete division gates and drop for East and West Branch secondary "C" canal, Sept. 19, 1913. Fig. 3 shows the secondary "C" canal and concrete drop C-4. This drop has stop-plank ways and is used to hold up the water to a high level when required.

DROP NO. 8-A—SECONDARY "A" CANAL

On the secondary "A" canal the original timber structures are being gradually replaced by permanent type concrete structures. A good illustration is furnished in the case of Drop No. 8A on the secondary "A" canal near Strathmore, Alta. (shown in Fig. 4), which was rebuilt in 1914. July 22, 1914, a construction crew was moved into camp near the old timber drop, one view of which is shown in Fig. 4. The new, reinforced concrete structure is of the notch-drop type and designed to pass 600 cu. ft. of water per sec., with a fall of 15′.

In order to avoid work in cold weather a by-pass was excavated ter-

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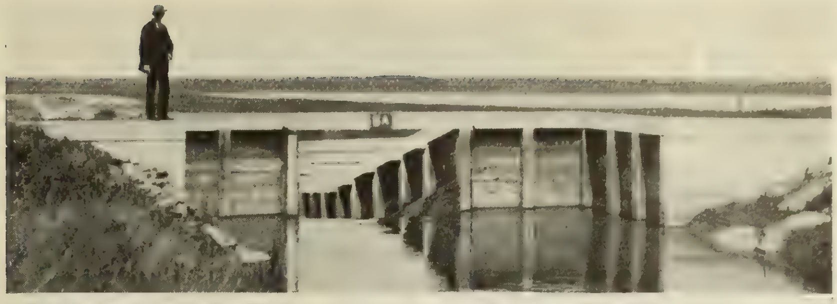
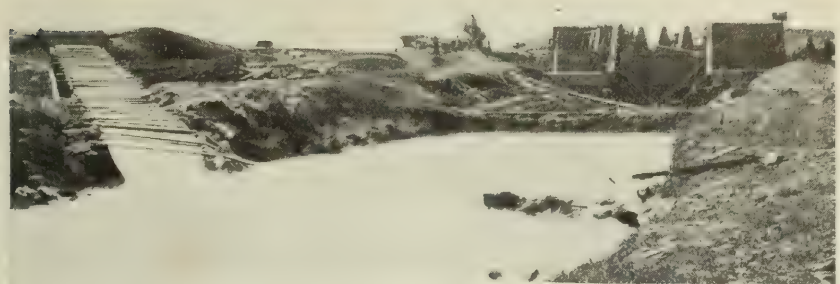
[1] Can. Pac. Ry. Co., Dept. of Nat. Resources, Strathmore, Alta., Can.





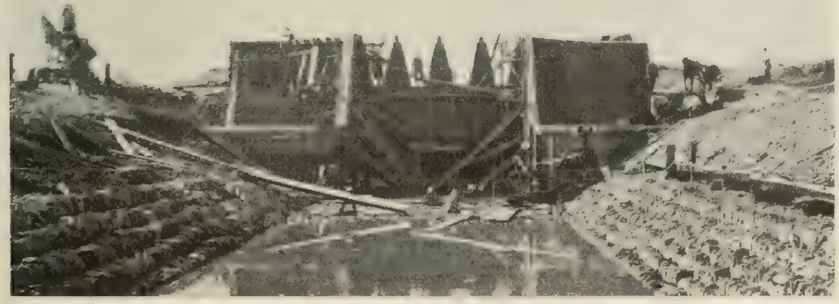
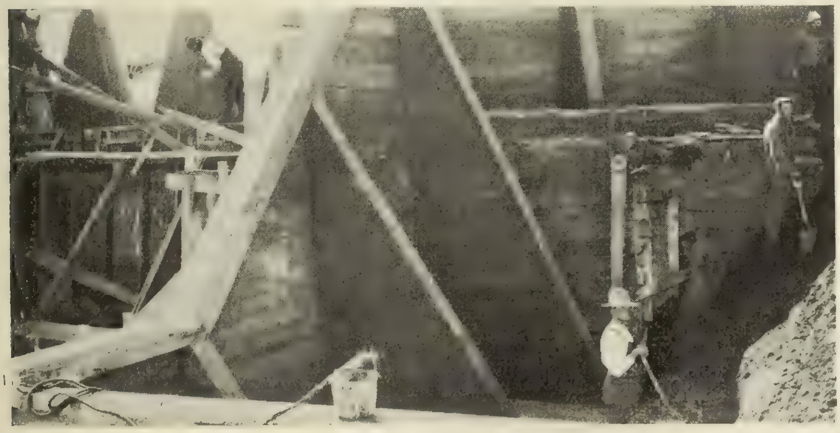


Fig. 4—Drop 8-A Secondary "A" Canal Before Reconstruction Was Started. Strathmore, Alta., May be Seen in the Distance Across Deacon Lake
Fig. 5—By-Pass Around Drop 8A Secondary "A" Canal, Strathmore District
Fig. 6—Riprap and Drop 8-A Nearing Completion, Secondary "A" Canal, Strathmore District



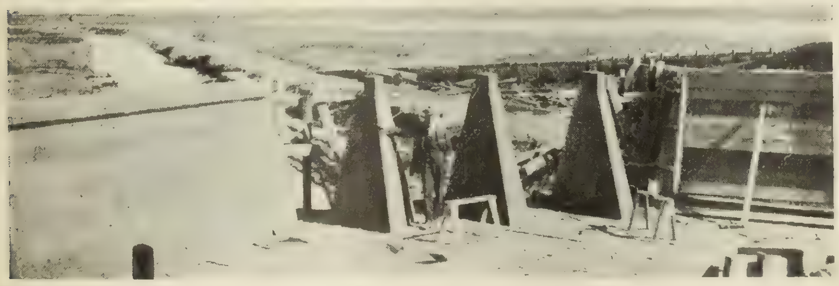


Fig. 7—Concrete Work and Backfill Being Puddled in Place, Drop 8-A Secondary Canal, Strathmore District
Fig. 8—Drop 8-A, Showing Notches, Upper Floor and Wing Walls as the Forms are Being Taken Off

Summary of Features Costs Drop 8-A—Strathmore District, 1914

Feature	Cost	Cost per cu. yd. of concrete
Camp expenses and supplies	$ 521.86	$ 2.071
Preparatory work (by-pass, drafting, etc.)	603.94	2.396
Hauling material	215.13	0.854
Excavation and backfilling at drop	623.16	2.473
Removing old structure and pumping drop	317.29	1.259
Framing and placing form work	391.80	1.560
Removing form work	56.75	0.225
Cutting and bending steel and placing same	121.62	0.483
Mixing and placing concrete	249.70	0.991
Steel and wire fabric	294.00	1.167
Cement	970.90	3.853
Gravel	483.00	1.916
Nails	15.00	0.054
Lumber	309.64	1.229
Coal	20.00	0.079
Depreciation	350.00	1.389
Overhead expenses	500.00	1.984
	$6,043.79	$23.983
Camp expenses, supplies and preparatory work	$1,125.80	4.467
Excavation and backfilling	623.16	2.473
Concrete work	3,444.83	13.670
Depreciation	350.00	1.389
Overhead charges	500.00	1.984
	$6,043.79	$23.983

minating in a timber and metal flume, discharging below the old drop. The diversion ditch was 530′ long and supplemented with 200′ of flume to drop the water to the canal grade and carried 150 sec.-ft. of water. A small dam was placed in the canal above and below the drop but water was not diverted until the use had fallen to an amount less than 150 cu. ft. per sec., which occurred Aug. 5.

The new drop was located so that the breast wall of the old structure was in part utilized as a back form for the breast wall of the new drop and this resulted in a large saving in excavation.

July 28 excavation was started and Aug. 4 the work of removing the old timber structure was begun. The timber drop contained 4,800 lin. ft. of sheet piling and 52,342 f. b. m. of lumber, besides a number of round piles. Owing to seepage water, it was necessary to pump all the time until the old floor was removed and filled to grade, and the new concrete floor was in place. The placing of forms began Aug. 31 and the last concrete was poured Sept. 25. The removal of forms was begun next day and finished Oct. 8. Backfillng was completed and the canal banks riprapped with rock for a distance of 150′ downstream and the canal bottom was lined with rock for a distance of 50′ below the drop. The camp was pulled in Oct. 9.

Fig. 5 shows the by-pass discharge and the drop during the process of backfilling and removal of the forms Sept. 26, while Fig. 6 is a nearer view of the drop showing the character of the riprap work.

Fig. 7 shows a good view of the concrete work as backfill is being puddled in place.

LABOR COST—DROP NO. 8-A—STRATHMORE

Feature	Quantity		Labor Cost	Unit Cost		Remarks
Drafting charges	....		110.00	......		
Moving Camp	....		58.17	......		About 8 mi.
Fencing camp	....		3.37	......		Making corral
Camp expenses	....		111.01	......		Hauling groceries, etc., and incidental expenses
Sundays and bad weather	....		349.31	......		
Excavation for diversion	1,824	cu. yds.	191.87	0.145		Considerable rock
Excavation for flume	60	cu. yds.	9.00	0.150		10 cu.yds. trenching
Erecting flume and crib work	8,086	f. b. m.	144.12	17.823	per M.	Includes placing of metal flume
Backfilling flume	82	cu. yds.	4.50	0.141		
Hauling lumber for flume	8,086	f. b. m.	9.80	1.212	per M.	Haul 2 mi.
Hauling metal for flume	1,530	sq. ft.	2.80	1.830	per M.	Haul 2 mi.
Hauling rock to riprap flume	3	cu. yds.	2.80	0.933		Haul 200′
Removing flume	8,086	f. b. m.	23.00	2.844	per M.	Includes removal of metal flume
Hauling material for temporary bridge	2,477	f. b. m.	3.96	1.600	per M.	Haul 2 mi.
Erecting bridge	2,477	f. b. m.	6.75	2.725	per M.	
Building dams across canal	71	cu. yds.	22.00	0.309		
Remove dams and refilling gaps in bank	216	cu. yds.	61.15	0.283		
Cribbing below drop	....		10.58	......		2,118 f.b.m. placed and 59 cu. yds. of rock
Removing rock from drop	10	cu. yds.	9.00	0.900		
Building cement shed	....		1.12	......		2 tents with floors
Excavation for drop	860	cu. yds.	159.50	0.186		Hand work
Excavation for curtain walls	20	cu. yds.	9.23	0.461		
Refilling drop	1,754	cu. yds.	354.53	0.202		Sand hauled 500′
Filling below floor of drop	156	cu. yds.	99.90	0.640	per M.	
Removing old structure	51,000	f. b. m.	207.52	4.069		
Pumping out water from drop	....		109.77	......		
Hauling material for forms, etc.	15,294	f. b. m.	11.20	0.732	per M.	Haul 2 mi.
Framing formwork	5,905	sq. ft.	223.45	0.038		
Placing formwork	5,905	sq. ft.	164.35	0.028	per M.	
Bracing face of old drop	192	f. b. m.	4.00	20.834	per M.	
Building material for runways	1.666	f. b. m.	2.80	1.681	per M.	
Building runways	1,866	f. b. m.	10.85	6.513		
Removing formwork	5,905	sq. ft.	56.75	0.009	per M.	Haul 2 mi.
Hauling steel to drop	84.04	cwt.	2.80	0.033		
Cutting and bending steel	84.04	cwt.	24.75	0.294		
Placing steel	84.04	cwt.	96.87	0.115		
Hauling gravel for concrete	250	cu. yds.	144.21	0.577	per M.	Haul 2 mi.
Hauling cement for concrete	1,342.32	cwt.	33.64	0.025		
Mixing and placing concrete	252	cu. yds.	249.70	0.991		
Hauling steam coal for mixer	4	tons	1.12	0.280	per M.	Haul 2 mi.
			$3,101.25			

MATERIAL COST—DROP 8-A—STRATHMORE DISTRICT

Feature	Quantity	Cost	Freight	Total Cost	Unit Cost	Remarks
Reinforcing steel	8,404 lbs.	138.66	130.44	269.00	0.032	1,230′—⅝-in. rods 1,614′—¾-in. rods 8,062′—½-in. rods
Wire Fabric	500 sq. ft.	25.00	......	25.00	0.050	Cost includes freight
Cement	357 bbls.	874.65	96.25	970.90	2.720	275 bbls. Exshaw brand 82 bbls. on hand
Gravel	250 cu. yds.	226.50	256.50	483.00	1.932	Irricana pit
Nails and spikes	375 lbs.	......	......	15.00	0.04	
Lumber	27,523 f.b.m.	619.27	......	309.64	11.25	50% salvage, cost includes freight
Coal	3 tons	......	......	20.00	6.67	for concrete mixer
				$2,092.54		

Total labor cost, including team feed	$3,101.25
Total material cost	2,092.54
Depreciation	350.00
Overhead charges	500.00
	$6,043.79

Fig. 8 shows the notches, upper floor and wing walls of drop 8A, as the forms are being taken off.

The cost of gravel was high as it was all shipped in by railroad and hauled two mi. by wagon. Some of the cement was old and the gravel not very clean; consequently a large portion of the concrete was mixed 4 to 1 and an average of 5.6 sacks of cement were used per cu. yd. of concrete. The finished concrete seems to be of excellent quality.

FIGS 9—DROP 10-A IN SECONDARY "A" CANAL

This drop was built in 1913 and is similar to 8-A except that the fall is less

A No. 1 Smith concrete mixer² with steam engine, boiler, and side loader was used on this job and gave good satisfaction.

The foreman on this work received $120 per mo., laborers $2.25 per da. of 10 hrs., teamsters $1.90 per da., including Sunday, and carpenters from 40 cts. to 50 cts. per hr. Cost of board was deducted at the rate of $5.50 per wk. Team feed was charged at 90 cts. per da.

ITEMIZED COST DATA—DROP NO. 8A

The accompanying detailed cost statements will show how this work was carried out.

A contemporary devotes a good deal of attention in a recent article to the clever way under which the Pennsylvania R. R. purchases its cement. This corporation, instead of contracting for the construction of its bridges, retaining walls and other work, when it closes with a contractor who is to supply labor and all materials of construction excludes cement from the materials the contractor is to supply, and the railroad itself agrees to furnish this particular ingredient. To accomplish this, it purchases from 10 to 15 different cement mills located principally in the Lehigh region between 300,000 bbls. and 400,000 bbls. of cement a year, all subject to inspection. The material is all bought according to the specifications of the Am. Soc. for Test. Mat., is all tested at the mills in bins which are sealed by the railroad inspector and which upon the expiration of the test are unsealed and shipments made therefrom. The effect of this method of purchase has been to secure a cement of uniform quality at all times and further to secure what is not always the case in concrete construction, namely, a sufficent amount of cement to the yard of concrete. It makes a great deal of difference whose ox is being gored and it makes a great deal of difference who is paying for the cement used.

Since the great San Francisco earthquake, Cal. has been a little shy of "big noise," but now comes along the Riverside Portland Cement Co., down in the southern part of the state, which has just created a miniature earthquake by using 70 tons of dynamite in a single blast. This is described as the biggest shot every fired in Cal.

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[2] The T. L. Smith Co., Milwaukee

Design and Construction of the Langwies Viaduct—Chur-Arosa R. R., Langwies, Switzerland

By Albert M. Wolf, C. E.[1]

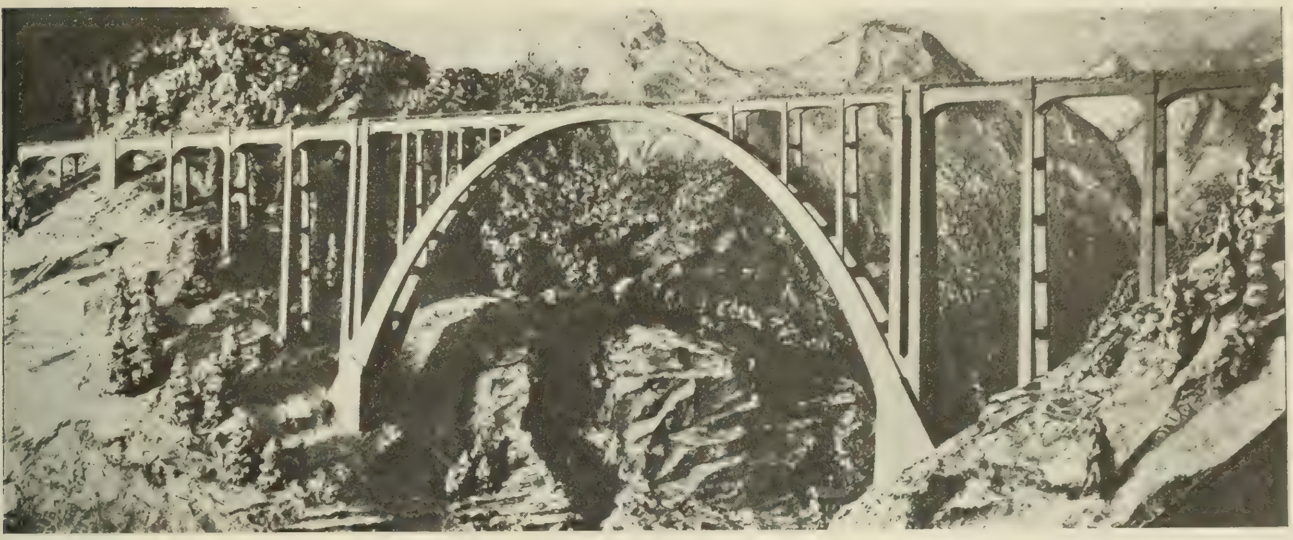

Fig. 1—The Langwies Viaduct, Chur-Arosa R. R., Langwies, Switzerland

Developments made in the design and construction of large concrete arches in the last decade have been toward the gradual increase in the main dimensions and the use of more economical and hitherto untried methods of supporting formwork. The structure herein described will therefore be of double interest on account of its gigantic size and the unique type of centering used in its construction. This arch span, the largest in existence, when one considers the span rise and the load carried, is that of the Langwies viaduct of the new Chur-Arosa R. R., in Switzerland. This arch has a clear span of 314′ ½″, a rise of 134′ 3″ and a crown height above the valley of about 203′. The span is about 13′ shorter than that of the Risorgimento arch over the Tiber at Rome, and 5′ shorter than that of the Auckland, N. Z., arch, while the rise exceeds that of the former by about 102′ and the latter by 50′. The Monroe St. arch at Spokane, Wn., with a clear span of 281′ and a rise of 113′, is the only structure with a rise which can be closely compared with that of this new arch. The Langwies arch is designed for a narrow-gauge electric railway, while the others are for heavy highway loading only. In esthetic design, it outranks by far the others mentioned and although not so artistic as the Larimer Ave. arch in Pittsburgh, it is an excellent example of a plain but graceful design.

GENERAL DESCRIPTION

The Chur-Arosa R. R., a 1-meter gauge electric railway now under construction, was financed by a company interested in the hotel business at Arosa, which has assumed large proportions on account of its prominence as a health and winter-sport resort. Until the present time the only means of access to Arosa from Chur has been by means of a very narrow, crooked and steep post-road. With the increase in business came the desire to have a more direct and satisfactory connection with the city of Chur, and the new railroad was the result. The road has a length of 26 kilometers or 16.15 mi., with a rise of 3,650′ in an almost constant 6% grade and involved the construction of 27 large stone bridges, three of steel and two large reinforced concrete arches, one of 282-ft. span and one of 330-ft. span, as well as 19 tunnels. On account of its location in the very mountainous region of Switzerland, some very heavy construction was necessary. From Chur to Langwies the line runs along the right bank of the Plessur river. At Langwies the line crosses to the left bank close to the junction of the Sapüner Brook with the Plessur, on a reinforced concrete arch bridge of unusual span across the gorge at an elevation of 330′ above sea level. This bridge is known as the Langwies viaduct.

The entire structure is of reinforced concrete construction with a total length of 935′, consisting of the 314-ft. 11½-in. arch span and four continuous girder spans of 52′ 6″ c. to c., carried on high concrete bents at each side of the arch, and three additional girder spans at the Langwies end (left end in Fig. 1). Two of these latter are of 42-ft. 8-in. clear span and one of 32-ft. 9½-in. clear span. The arch is composed of two reinforced concrete ribs with fixed ends, braced at intervals by transverse struts, the over-all width at the crown being 16′ 6½″. The roadway deck is carried by continuous girders supported on reinforced columns spaced about 29′ 6″ o. c. longitudinally, resting on the arch ribs.

CONDITIONS AND LOADINGS GOVERNING DESIGN

Structures of stone masonry and steel were first considered, but the lack of satisfactory building stones and the difficult and rough roads made the use of stone masonry or

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[1] Princ. Asst. Engr., Condron Co., Struct. Engrs., Chicago

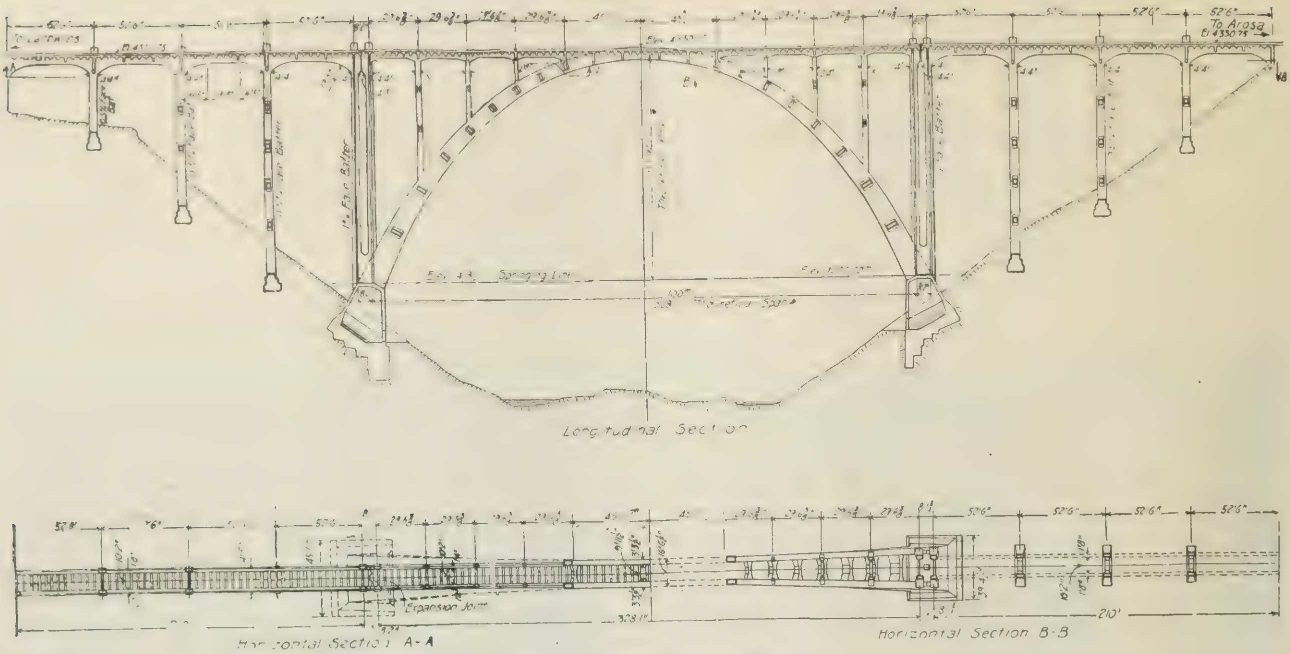


FIG. 2—LONGITUDINAL SECTION, LANGWIES VIADUCT, LANGWIES, SWITZERLAND

steel structure practically impossible. The abundance of good sand and gravel in natural deposits at the site of the bridge was responsible for the selection of a reinforced concrete structure. The Swiss department of railways at first made strenuous objection to a reinforced concrete structure on the ground that the dimensions of the bridge were too great to allow the safe use of reinforced concrete. This objection, however, was overcome by the Zublin Co., Strasburg, contractor for the structure, after considerable consultation with the government officials, and work began on the noteworthy structure in the summer of 1912.

A long-span arch was of course the logical solution of the problem of bridging the deep mountain gorge and for economical reasons, and because of its greater resistance to wind and strength against buckling as a compression member considered as a whole a twin arch was used. On account of the very favorable foundation conditions, the main arch was proportioned and designed as a fixed arch in accordance with the method of the elastic theory, the temperature and the rib shortening stresses being minimized by the rise of the arch ribs. The structure as designed required no reinforcement for dead anl live load stresses, being so proportioned as to keep the line of pressure well within the middle third of the ribs. To provide for such tensile stresses as might arise due to temperature changes and rib shortening alone or combined with the dead and the live load stresses, steel reinforcement was used in both extrados and intrados of the arch ribs.

For the approach spans continuous girders were decided upon because the great height of the roadway above the ground made a structure free from horizontal thrust very desirable.

The structure being subjected to great variations in temperature because of its altitude of 4,330′ above sea level made special provision for expansion necessary. The roadway deck was therefore divided by expansion joints at the double piers over the arch abutments, the high intermediate piers being sufficiently elastic to permit longitudinal expansion of the deck without overstressing them.

The main objects to be fulfilled in the design and construction of this bridge were: (1) To keep the actual stresses as low as possible and at the same time (2) to save as much material as possible. On account of the relatively small live load as compared with the dead load, these conditions could readily be complied with by the use of an arch composed of two ribs instead of a solid barrel arch.

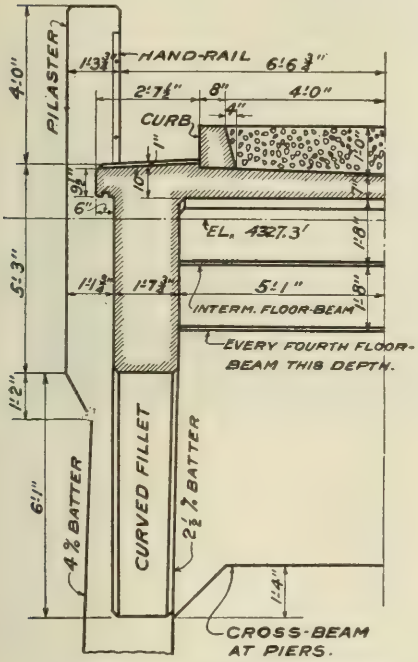
By designing the deck of the approach spans as a series of continuous girders which transmit the wind stresses directly to the end abutments, and to the large double piers over the arch abutments, the approach piers could consistently be made of light construction consisting of two main posts of reinforced concrete tied together by struts of the same material. Because of the stresses transmitted by this method of design to the double piers, it was necessary to connect each pair of these posts with a solid transverse wall.

In order to secure greater stability, the exterior faces of the arch ribs were given a 4% batter or flare from crown to the abutments. The inside faces of the ribs were also given a 2½% batter toward the abutment, but not so much as to the outside faces, in order to secure the additional required strength toward the springing line.

Live Loads.—The live load used for the design of the viaduct consisted of one train of two electric locomotives each of 65 tons maximum weight (locomotives of the Rhätische Bahn) followed by an unlimited number of freight cars.

For computing the longitudinal girders over arch and approaches and the roadway slabs an additional live load was added in accordance with the formula (15-1)%, where 1 was the span in meters. Temperature stresses due to a range of 27° F. were considered in design, as well as shrinkage stresses due to a further decrease of 36° F. The allowance made for traction or braking loads was 1/7 of all wheel loads. A further load due to wind was considered in design, the allowance being 20 lbs. per sq. ft. for loaded structure and 30 lbs. per sq. ft. for the structure alone, the exposed area being considered as follows: face of girders, twice the area of front face of columns, 1½ times the front face of double piers, and for trains a surface 10′ high, pressure acting at 6′ 6″ above the rail.

Unit Stresses.—The allowable unit stresses used in design were, for dead and most unfavorable condition of live load, 495 lbs. per sq. in. (35 kg. sq. cm.) compression in concrete; while for combined streses due to dead and live loads, shrinkage, temperature, traction, and wind stresses the compression in concrete allowed was 639 lbs. per sq. in. and the stress in steel 17,040 lbs. per sq. in. The allowable shear in concrete was 57 lbs. per sq. in.



ONE-HALF CROSS-SECTION MAIN APPROACH SPANS.

The modulus of elasticity of concrete was taken as 2,800,000 lbs. per sq. in. and the ratio Es/Ec as 15. All concrete was sampled and tested daily and when poured as a plastic or wet mass, was required to have a strength of 2,556 lbs. per sq. in. at 28 das., and 3,550 lbs. per sq. in. for dry mixed or slightly moist concrete.

In the arches and columns and those parts of the structure where the stresses are mainly compressive, the stresses were computed by the "Ritter" method. For members subjected to bending the compressive and tensile stresses were computed by the Christophé method, due allowance being made for the strength of concrete in tension due to bending, which is in accordance with the Swiss regulations. The shearing stresses were very carefully looked into and wherever they exceeded 57 lbs. per sq. in. stirrups were used to take up the entire stress. This condition necessitated the use of a great amount of steel in the shape of stirrups.

Esthetics.—The appearance of the entire structure is one of extreme lightness, in spite of the massive character of the work. This is due to the great height of the arch and the approaches, and the comparatively light construction used in the roadway deck supports. The architectural treatment of all parts of the viaduct is very simple, the plain but graceful lines, the balance of proportion of parts, the gigantic size of the structure and the picturesque surroundings in a very rugged mountainous country being relied upon entirely for the artistic beauty of the work. The ingenious method used to preserve the symmetry of the main structure is worthy of comment. At

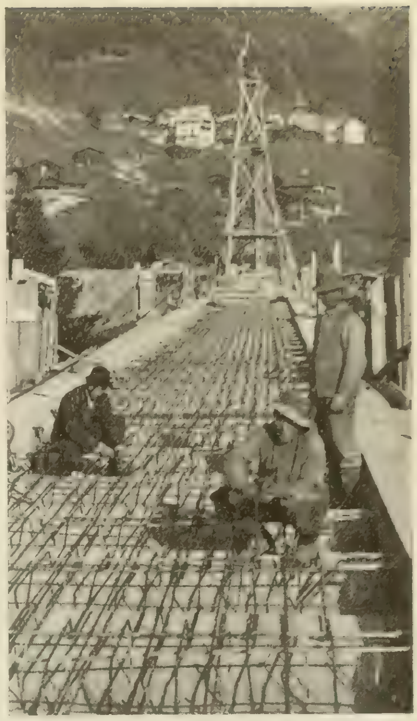
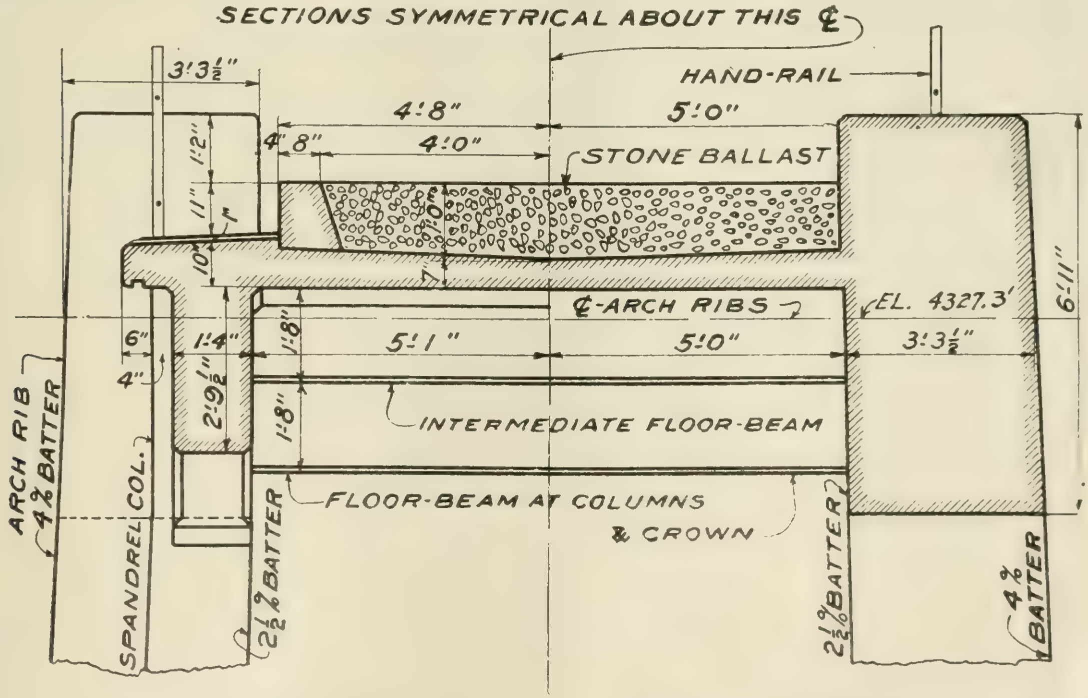


Fig. 4—Reinforcement of Deck



CROSS SECTION OF DECK CONSTRUCTION OVER ARCH.

CROSS SECTION NEAR CROWN OF ARCH.

Fig. 3—Cross-Sections of Main Approach Spans, Deck Construction Over Arch and Near Crown of Arch

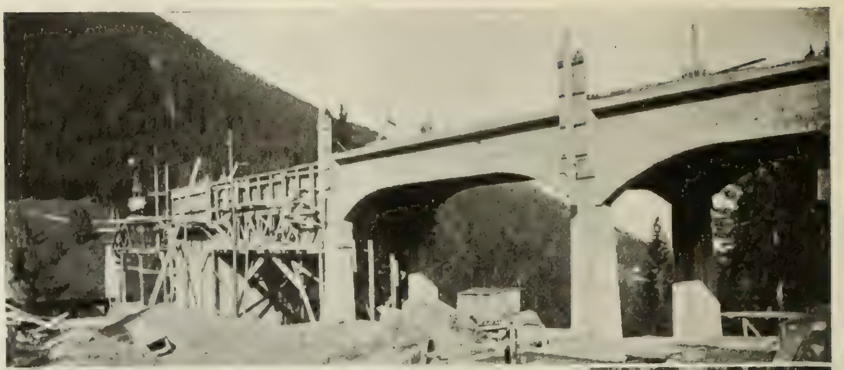
the Langwies end, as shown in Fig. 1., are three additional approach spans (only two are visible) separated from the four main approach spans by a heavy abutment pier. This fectually divides this approach into two parts and makes a much more pleasing design than would have been obtained had this pier been of smaller proportions, which would have given the structure an unbalanced appearance.

DETAILS OF DESIGN

Arch.—The main arch ribs, two in number, have a theoretical span of 100 m, or 328′ 1″ and a clear span of 314′ 11½″ with a theoretical rise of 137′ 9½″. The ribs are 2.10 m. or about 7′ deep and 3′ 3½″ (1 m) wide at the crown. The depth of the ribs is increased toward the springing line so as to keep the line of thrust within the middle third. The width of ribs is increased from crown to spring in accordance with the batters previously given. Plain round bars of medium steel placed near the intrados and the extrados of the ribs form the reinforcement which provides for temperature and rib-shortening stresses. At intervals of about 15′ (measured horizontally, and not following the line of ribs) the ribs are tied together by reinforced concrete struts with heavy fillets at the rib connections to give added stiffness. At the crown the ribs are spaced 9′ 11½″ apart and they extened a little above the level of the deck, thus preserving the outline of the arch ribs very effectively (see Fig. 1).

Arch Abutments.—The arch abutments, consisting of two pyramidal blocks of plain concrete, one under each rib, connected by reinforced slabs at bottom and front, are carried down to solid rock, with the bottoms stepped or serrated to aid stability and prevent sliding and at the same time to follow closely the line of rock surface. The abutment faces are vertical while the backs are sloped in a line parallel to the thrust line in the arch ribs at the springing line. The left abutment (see Fig. 2) is 45′ 11″ wide, while the right abutment is 39′ 4½″ wide only, the difference in width being due to the difference in character of the foundations encountered on the two sides of the valley.

Arch Span Roadway Deck.—The roadway deck over the arch span (see Figs. 2 and 3) is carried by four pairs of posts, at either side of the crown, spaced 29′ 6″ centers, and securely doweled to the arch ribs. These posts or columns are of reinforced concrete varying in width from 1′ 8″ for those near the crown to 4′ 4″ for those over the abutments. The two intermediate pairs are tied together by transverse struts as shown in Fig. 2 to make the posts act as framed bents. Over the abutment are twin piers, each consisting of two heavily reinforced posts tied together for their entire height by a solid reinforced concrete wall instead of struts. These piers, which are 4′ 4″ apart, are tied at the bottom near where they intersect the arch ribs and are separated at the top by an expansion joint. One acts as the end pier for the roadway girders over the arch and the other as the end pier of the approach span.



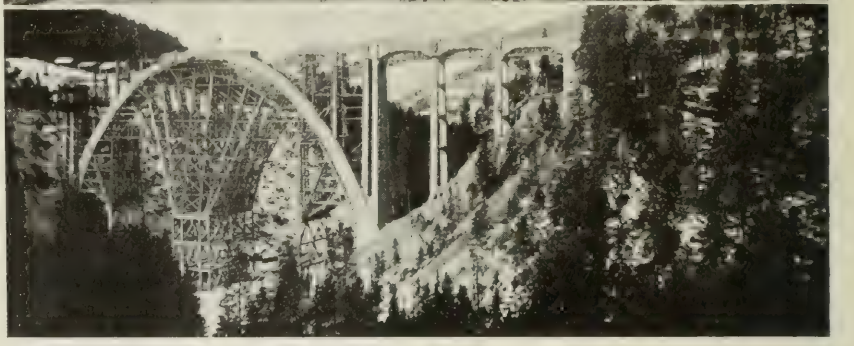


Fig. 5—Side View of Girders for the Approach Span

Fig. 6—Progress View of Viaduct, Showing Arch Centering

The deck construction consists of a thin reinforced concrete slab carried on cross-beams, spaced about 4′ 2″ o. c., supported by longitudinal spandrel girders continuous over the spandrel columns. The girders are rigidly connected with the arch ribs near the crown and also with the tall piers over the abutments, which by their elasticity provide for the expansion of the deck. The cross-beams at the spandrel columns are of greater depth than the others to provide extra lateral stiffness since they act as part of the framed bent formed by the spandrel columns. All slab and girder connections to their supports are provided with haunches to care for the compression due to continuous action.

The roadway is 13′ 1½″ wide between railings, with a space 2′ 4″ wide on each side of curbs for sidewalks. The waterproofed deck slab will be covered with a layer of sand and then a layer of crushed stone 1′ deep, upon which the track will be placed.

Approach Spans.—The roadway deck construction for approaches, including cross-beams and slab, is the same as that just described and is shown in detail in Fig. 3. Fig. 4 shows the reinforcement in place for the deck of the approach spans. It will be noted that the longitudinal girders were concreted first, with reinforcement for cross-beams in place and anchored into the side girders. After this the floor reinforcement was placed and the concrete then poured. The cross-beams are reinforced with bent-up bars, stirrups and compression bars in the top; over these the slab steel is bent up from the bottom of the slab to form negative reinforcement.

The main girders of the approach spans are of much longer span than those over the arch. viz: 52′ 6″ c. to c. or 48′ 2″ clear span, and consequently of greater depth and width, the latter being 1′ 8″ as against 1′ 4″ for those over the arch. These girders are designed as continuous beams with a variable amount of inertia, with rigidly fixed ends at the cellular abutments and elastically framed into the intermediate piers and the double piers over abutments. The ends of girders are curved to a radius of 19′ 8″ for a portion 16′ 5″ out from the center lines of columns or piers with a tangent portion 19′ 8″ long, between. This gives them a very pleasing appearance as well as adding greatly to their strength. Fig. 5 shows two of the completed approach girder spans and centering in place for two others.

The approach piers each consist of two posts 4′ 4″ wide with battered faces, resting on stepped footings carried down to rock. The posts or columns of the higher piers are tied together at intervals by cross-struts with heavy fillets at the ends. The columns of the approach piers and the double piers over the abutments are carried up above the deck as projecting pilasters, thereby defining more clearly the approaches from the main arch construction.

The three additional approach spans at the Langwies end are not shown in Fig. 2; their construction, however, is the same as that of the other spans but they are designed to act independently of the others, being separated by a wide abutment pier.

CONSTRUCTION

General.—General construction work was started in Aug., 1912. The arch centering was started in the spring of 1913 and completed about the middle of Oct. and the approach spans at the Langwies end were practically complete at this time. Fig. 6 shows the viaduct as it appeared after stopping work for the winter in Nov., 1913. The approaches at the Arosa end were not so far advanced, little more than the foundation work being completed.

On account of the early and severe winter prevailing in the mountains until the end of Mar., work was suspended during the winter and the bridge was completed July, 1914, and opened for traffic in the fall of 1914, when the new Chur-Arosa railroad opened.

Foundations. — Excavations for foundations were carried down to solid rock through the moraine and drift formations. The necessity of penetrating the moraine deposit caused considerable delay in the construction on account of the extra depth of excavation required at one abutment in order to obtain the desired solid rock foundation.

Centering and Falsework.—The viaduct itself is a notable structure, but to many the unique type of centering used for the construction of the main arch ribs will be of more interest particularly on account of the fact that reinforced concrete was used as a part of the falsework. Concrete has been put to many uses in this country, but there are no records of its use in this connection, that of a temporary construction; consequently there is much of interest to be found in the details of this work.

This centering consists of a central fan-like wooden falsework of radial ribs, securely braced both diagonally and horizontally, supported on a reinforced concrete tower consisting of four bents connected by rigid framing, and two single reinforced concrete bents, one near each abutment, supporting wooden falsework in the shape of a half-fan with ribs radiating toward the abutments. The wooden falsework consists mainly of round and half-round unhewn timber which was on the site in good quality, long lengths and obtainable at low prices. The reinforced concrete towers supporting the wooden falsework were designed as latticed bents.

The following considerations led to their adoption for the lower part of the centering:

(1) On account of the great danger of flood to which the location is subject during the melting of the snow, situated as it is at the juncture of two rapid streams which often carry enormous quantities of water and solid matter (driftwood, boulders, etc.), it was necessary to restrict the waterway as little as possible. For this reason it was impossible to use vertical bents for the falsework and the tower system had to be used. Wooden towers would not have been so safe as the adopted concrete towers and would have considerably more reduced the waterway.

(2) Even if wooden towers had been used to support the centering, the foundations would necessarily have had to be of concrete, as to drive piles through the moraine deposits of gravel and large boulders was absolutely impossible.

(3) It was desired to reduce the vertical deformation (compression) of the centering to a minimum during pouring of the arch ring. This could be obtained much better by the use of reinforced concrete towers than by using wooden towers.

That the adopted design was a success in this particular is witnessed by the fact that after the arch ribs were completed a total settlement of a trifle less than 20 mm. (¾″) was observed in the centering.

DETAILS OF ARCH CENTERING

Central Tower.—The central portion of the arch centering is carried on a three-story tower consisting of four reinforced concrete bents. These bents, 77′ high and 60′ 8″ wide, are tied together at all intersections of the lattice framing of each bent, by horizontal struts of reinforced concrete, and rest on footings of concrete. The two middle concrete bents are spaced about 20′ apart while the distance between these and the other bents is only about 10′. The two intermediate bents are tied together with diagonal tension rods in addition to the horizontal concrete struts.

Each bent is designed as a latticed frame with the intermediate members set on the diagonal so as to shorten the span at the top chord or sill and transmit the load as directly as possible to the vertical members and footings. The horizontal struts at intersection in the plane of the bent are much lighter than the other members. In the second story of each bent, two tension rods take up the stresses produced in the frame by the outer diagonals in the upper story. The details of arrangement and the size of the various members are shown in Fig. 7. When one considers that this massive tower is only a temporary structure, the magnitude of the work is more firmly impressed on the mind. It demonstrates conclusively the remarkable possibilities of reinforced concrete as an aid in carrying out heavy and difficult construction work. Fig. 8, showing the framework in place for the central concrete tower, gives some idea of the size of this temporary work.

The central falsework of wooden timbers carried on the concrete tower consists of two vertical bents at the middle and four inclined bents on each side (See Fig. 9). The two vertical bents and the two intermediate inclined bents on each side are made up of four lines of struts parallel to a vertical plane passed through the center line of the structure and two inclined lines of wind-bracing struts outside of these. Each one of these lines consists of double rows of round unhewn timber securely tied together by horizontal and diagonal sway bracing. The four inner lines of struts are so spaced in pairs as to be directly under the arch ribs, and therefore transmit practically all of the dead load to the tower. The first and the last inclined bent on each side are the same as those just described except that the inclined lines of wind-bracing are omitted. All of these transverse bents are tied together by lines of longitudinal bracing both horizontal and diagonal. All bents are composed of round or half-round timbers and are blocked up by hardwood wedges on the concrete tower bents.

Near the top the bents are tied together by a line of arched struts following very closely the line of arch rings. Above this they branch out into three sets of struts, one extending in the same direction as the bent and two set diagonally and capped with lines of saddle ribs following the line of arch rib, thus forming a truss construction to carry the arched timber ribs upon which are placed the transverse joints and supporting the lagging and forms for the arch ribs. Fig. 10 gives an excellent idea of the transverse bracing used in the falsework. Each longitudinal bent of falsework was laid out before erection and framed complete on a large platform on the ground near mid-span (See Fig. 7).

Side Towers.—The side towers

near the abutments consist of single bents of reinforced concrete built in a manner similar to those of the central tower, as shown in detail in Fig. 7. The main members of these side bents are much thicker than those of the central tower: viz: 3′ 4″ as against 1′ 8″ (measured in a direction transverse to the bent.) These latticed frames which support one vertical and two inclined bents of timber falsework are tied to the abutments by steel I-beams to brace them longitudinally and care for the thrust caused by the inclined timber bents. (See Figs. 7 and 9). The side bents are tied to the central falsework near the top of the former by a continuous set of horizontal and diagonal, longitudinal timber bracing. The timbers of the bents are blocked upon the concrete frame by means of hardwood wedges, resting on short blocks of concrete placed across the top of the concrete frame, which is widened at that point to receive them.

Framing of the falsework over the side towers differs from that in the central portion in that six lines of struts or posts parallel to a vertical plane passing through the center line, are used in each bent instead of four. The batter of the inclined wind-bracing struts is also much less on account of the bent being only about 40′ wide instead of 60′ as for the central tower. The general framing, however, is similar to that above the central tower and is shown in detail in Fig. 7.

Centering for Approaches.—The approach spans piers were built up in forms partially self-supporting, a light wooden framing of round timbers being built up around the piers to assist in holding the top portion of forms in line.

Forms for the girders and deck construction are carried on pairs of steel trusses under each side girder, with top chords following very closely the desired outline of the bottoms of the girders.

These trusses were made somewhat shorted than the distance between piers, and were therefore easily raised in successive lifts by means of block and tackle, and with the aid of the light falsework around the towers, to their positions at the top of piers where they rest on projecting brackets built on the tops of pier columns. (See Figs. 9 and 11). The trusses are securely braced and tied together, and designed to carry the entire construction load of the span, including the roadway deck, which was concreted at the same time as the girders. Fig. 9 shows the centering trusses for the two right-hand approach spans in place and the wooden forms for the girders and deck under construction. The trusses for the other spans are being raised into position. The trusses were taken down after completing the approach at the Langwies end of the viaduct and used in the construction of the other approach.

Concreting.—Concrete was mixed at one plant located at one end of the structure and carried from the mixing plant to the structure in large buckets traveling on an aerial cableway. The bucket conveyor was so arranged as to permit lowering and discharging at any point on the work.

The concrete was mixed rather dry and was thoroughly rammed and tamped after placing. Concreting was carried on simultaneously on both arch ribs, starting from the springing lines at both sides. After

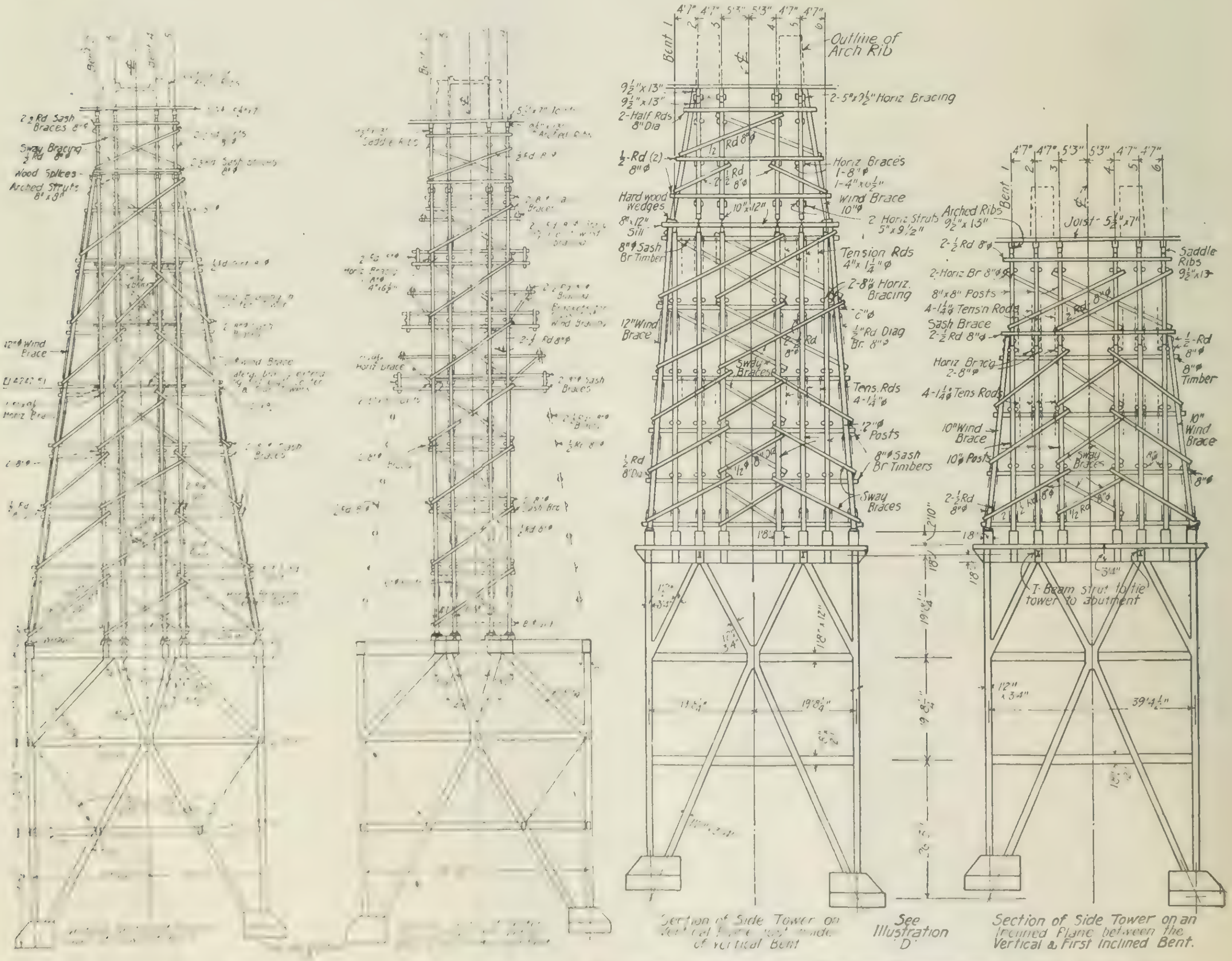


Fig. 7—Details of Reinforced Concrete Tower, Central Falsework Tower and Timber Centering Under Arch Spans

placing a section of concrete at the springing line on each side, work was started at the crown and carried on in both directions to meet the side sections. Work on these three sections was carried on continuously until predetermined keyways were reached, where the ribs were afterward keyed together. The high piers were poured in sections of considerable height, the forms being raised and placed for another section a few days after completing the previous one. The construction views shown give a clear idea of how the work was carried on.

COMMENT

The viaduct was designed and built by Ed. Züblin & Co., engineers and contractors, Strasburg, Germany. The writer is indebted to H. Schürch, chf. engr. of the above company for plans, photographs and data used in this article.

Placing Concrete at Panama

In the construction of the north entrance pier at Balboa, which is connected with the north wall of dry dock No. 1, a gang of men operating a $\frac{1}{2}$-yd. Austin cube mixer, equipped with an elevator and movable chutes, mixed and placed 540 batches of concrete Mar. 9. In place, the 540 batches measured 275.5 cu. yds. and this was placed in 7 hrs. and 15 min., actual working time. In the 8 hrs. work, there were the following delays: Broken chute, 10 min.; repairs to mixer, 20 min.; moving mixer ahead, 15 min.; total delays, 45 min.

The labor cost, including supervision, was $39.91, which makes a unit labor cost for mixing and placing of $0.1448 per cu. yd. All the material was wheeled in wheelbarrows from a point about 100′ from the mixer. The average run per hr., actual working time. was 36.33 cu. yds.—*Canal Record.*

At a meeting of the Executive Committee of the Pan-Am. Rd. Congress, held in N. Y. C., Apr. 16, it was definitely decided to hold the Congress at Oakland, Cal., the week of sept. 13. This date was fixed upon, owing to the advantageous arrangements that could be made for halls for meeting places, and also because it was felt that this date would enable engineers who would attend the International Engrg. Congress to attend the Pan-Am Rd. Congress as well. The members of the committee reported good progress, and the outlook is most excellent for a great gathering of road builders. The program will include speakers of national and international reputation as experts in the construction, repair and maintenance of highways. The Pan-Am. Rd. Congress will be held under the joint auspices of the Am. Rd. Bldrs.' Assn. and the Am. Highway Assn.

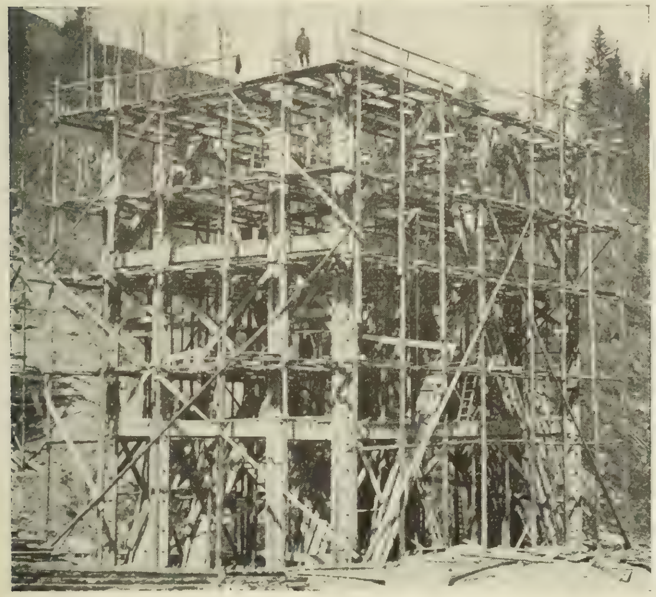


Fig. 8—Forms in Place for Central Concrete Tower

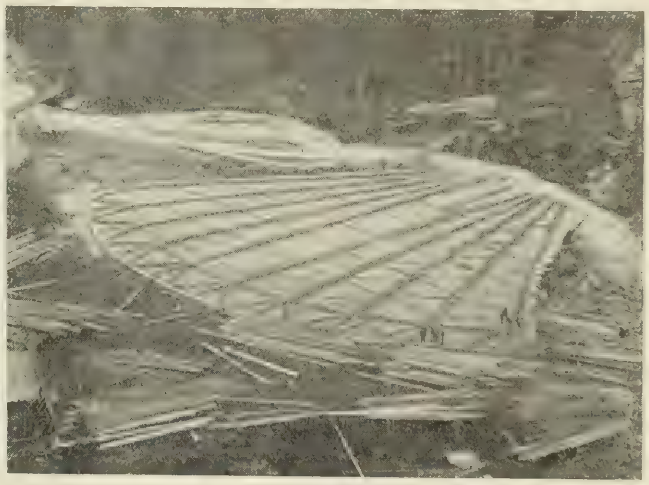
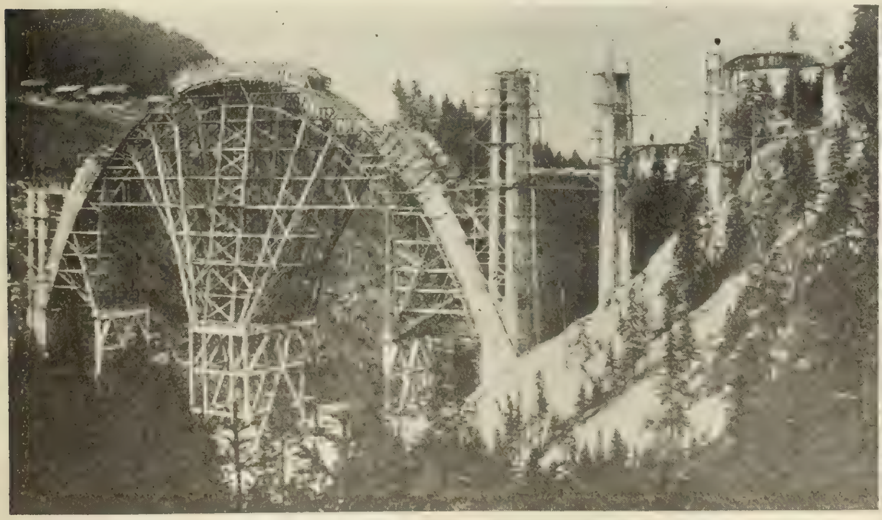


Fig. 11—View of Falsework Framing Platform



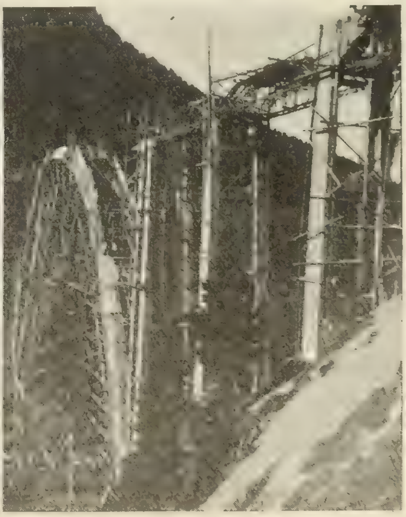


Fig. 9—Completed Falsework of Arch Span

Fig. 10—End View of Arch Centering, Showing Approach Towers in Foreground

Information and *Consultation*: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Splitting of Concrete Sidewalks Surrounding Iron Posts

Discussed By Carl H. Fuller,[1] Leonard C. Wason,[2] Benjamin A. Howes,[3] C. J. Case[4] and C. J. Bennett[5]

"1. What causes the splitting of concrete sidewalks surrounding iron street name-posts, fire hydrants and trolley posts of street railways?

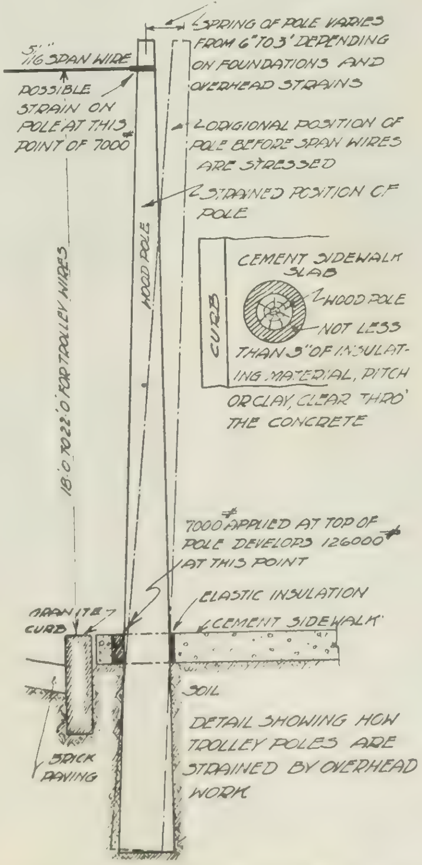
"2. Is it possible for corroded metal to continue the destruction of the concrete after the cracks are once started?

"3. What remedy would you suggest to prevent the bursting action that results from embedding iron or steel objects in concrete or passing them through it?"

By Mr. Fuller

It is not an uncommon sight to see long stretches of concrete sidewalk disfigured by being badly split, checked and broken or curbing pushed out of line where the slab surrounds and comes in contact with trolley poles, public service poles, fire hydrants and such obstructions, which extend through the sidewalk to various depths in the soil below. A little careful consideration of the subject will show these defects to be largely the result of carelessness and incompetence on the part of the mechanic who does the work and to ignorance or indifference on the part of those supervising the work; nor should the contractor be blamed for not taking the necessary precautions under the present methods of competition, when the city or the owner is willing to risk such possible disfigurement in order to effect a very small saving in first cost.

The writer has long been an advocate of 3′ or more of street lawn between the curbing and the edge of the sidewalk, which not only provides sufficient space for these inevitable obstructions, where they will do the minimum of damage, but affords an opportunity to beautify the street by planting trees. However, there are many places in every town, where the sidewalks, of necessity, extend from the curb to the building and in such locations the application of a little common sense and some slight additional expense, infinitesimal when compared with the results obtained, will eliminate $\frac{9}{10}$ of such unsightly defects, if applied when the sidewalk is laid or when holes are cut in old sidewalks for new poles.


SPRING OF POLE VARIES FROM 6" TO 3' DEPENDING ON FOUNDATIONS AND OVERHEAD STRAINS
5/16 SPAN WIRE
POSSIBLE STRAIN ON POLE AT THIS POINT OF 7000#
LORIGIONAL POSITION OF POLE BEFORE SPAN WIRES ARE STRESSED
STRAINED POSITION OF POLE
WOOD POLE
18'0 TO 22'0 FOR TROLLEY WIRES
CEMENT SIDEWALK SLAB
CURB
WOOD POLE
NOT LESS THAN 3" OF INSULATING MATERIAL, PITCH OR CLAY, CLEAR THRO' THE CONCRETE
7000# APPLIED AT TOP OF POLE DEVELOPS 126000# AT THIS POINT
ELASTIC INSULATION
GRANITE CURB
CEMENT SIDEWALK
SOIL
BRICK PAVING
DETAIL SHOWING HOW TROLLEY POLES ARE STRAINED BY OVERHEAD WORK

Sketch Showing Concrete Sidewalk Surrounding Trolley Pole

The causes of the trouble differ, depending on the object set through the walk and the purpose for which it is put there, but the resulting effect, the destruction of the walk, is the same in any case and the remedy, described later, is simple.

Usually the street railway company's trolley poles are the most destructive of all of these obstructions and the reason is not far to seek, if we take our attention from the sidewalk itself, for a few moments, and consider their purposes and methods of erection. Usually these are of wood, generally untreated (which is immaterial, any way) and therefore subject to considerable shrinkage or expansion owing to atmospheric changes. One who has not given the subject much thought may object that a wood pole alternately dry or saturated by rain would not swell sufficiently to check and break the surrounding slab of concrete. As evidence to the contrary, one of the methods of quarrying fine building stone is to drill a row of holes along the desired line of cleavage, sometimes several feet in depth, plug them with kiln-dried wood plugs, then saturate these plugs with water. This process will split huge slabs of the hardest granite, so what chance has the poor, thin little slab of concrete, against the destructive force generated by a swelling pole?

There is another factor of still greater destructive tendency, regardless of whether the pole be of iron or of wood, and that is the enormous strains induced by what the street railway man calls his overhead work. The pole-setting gang sets the pole with a slight inclination away from the trolley, sometimes as much as 3′ from the perpendicular at the top, as shown in the accompanying illustration. The trolley or line crew then connects these poles together in pairs, by a $\frac{3}{16}$-in. or a $\frac{5}{16}$-in. stranded wire cable some 18′ or 22′ from the ground, and by means of tackle strains these poles into a plumb position. On high-class work the pole man frequently fills the hole in which the pole is set with a low grade concrete, to give it greater stability and a $\frac{5}{16}$-in. span wire cable at the top is capable of producing a 7,000-lb. pull, which, if the pole is capable of withstanding such a strain, induces a permanent set or spring in the pole with a possible strain or reaction at the point at which it passes through the sidewalk up to 125,000 lbs. The line foreman counts on this resiliency of his poles to take up the slack in the overhead incurred by the expansion and the contraction of the connecting wires. Between the cool of midnight and the heat of noon time, the tops of a pair of trolley poles will vary 1′ or more in relation to each other, and this movement to a lesser degree but greatly multiplied in stress effect is communicated to the surrounding slab of sidewalk which is absorbing a shock it was never intended to carry and being of a comparatively unyielding composition, breaks away at the point of contact.

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[1] Cons. Engr., 716 N. East St., Indianapolis

[2] Pres. and Mgr., Aberthaw Constr. Co., Boston

[3] Engr. and Contr., N. Y. C.

[4] Contr. and Bldr., Troy, Pa.

[5] State Highway Commr., Hartford, Conn.

Telephone and telegraph poles, though stressed in a different manner and more uniformly along their center line, affect the sidewalk in a lesser degree, but anyone who has seen a thoroughly sound new pole some 12″ to 20″ in diameter, sheared off clean at the sidewalk line, from the stressing of numerous overhead wires will readily appreciate the enormity of these strains which must produce a resultant in the sidewalk or the foundations below it.

Sometimes these strains are of a torsional or twisting nature and the writer has seen one case in which the twisting power of the overhead wiring applied at the top of a 60-ft. pole of 20-in. butt, was sufficient to separate the fibres of the wood at a point within easy reach sufficiently to permit the passing of an ordinary hand ax through the hole without severing a single fibre of the wood. Where such strains are produced, is it any wonder that the sidewalk suffers?

With fire hydrants, the strains are largely temperature strains, but, being connected to the city mains by unyielding cast iron pipe and bedded in the cool earth the rate of expansion differs from and is not coincident with the temperature variations in the thin, flat and exposed sidewalk slab so that movement does not necessarily take place in the same direction and so produces destructive results.

There are numerous other poles of different types and purposes, set through the sidewalk, not always connected but all more or less firmly bedded in the underlying soil. The sidewalk slab is bound to move as it expands under the rays of the sun and as all of these obstructions are opposed to the normal movement of the slab they are destructive in their inflence.

As a remedy, when building new sidewalks around such obstructions, the writer usually specifies that a space of approximately 3″ be left clear of concrete around them, giving them an opportunity to perform the functions imposed by saturation, overhead strains or expansion, without injury to the walk. This may be readily effected by wrapping several thicknesses of Carey Elastite[6] (material is $\frac{1}{2}$″ thick) or other expansion filler around each pole before concreting, or a circle of tin, leaving the desired clearance, may be bent around the pole to make a form against which to finish the concrete. If the latter is used, care should be taken to fill the space between the tin and the pole with clay, sand or pitch to prevent a careless workman from defeating the object of such precautions by disposing of surplus cement in the interstice. When it is desired to prevent the water from entering between the slab and the pole, a soft pitch makes a good insulating material as it readily accommodates itself to any movement of the pole or the sidewalk.

Where a hole is cut in an old sidewalk for a new pole the same precautions should be taken in patching the paving as outlined for new work.

Where poles have already been set and the sidewalk laid flush with pole, any further development of cracks and checks may be prevented by chipping out a ring of concrete around the pole and filling the interstice with pitch.

It is doubtful that the corrosion of metal embedded in the concrete has any serious influence in making such checks and cracks in the sidewalk. It is a fact that iron or steel when properly protected seldom rusts appreciably and concrete rich in cement forms a high-grade rust insulation as evidenced by the bright tool marks found on steel removed from concrete in which it has been embedded for long periods. If the iron poles are insulated from the concrete as described the effect of corrosion, other than a slight stain, need not be feared.

The writer does not advocate such insulation as a cure-all for defects in sidewalk work, but experience and observation have demonstrated that the results fully justify such precautions. It is to be regretted that owners and city supervisory forces do not appreciate more fully the necessity of caring for expansion in a less perfunctory way than is customary. Nearly every city engineer has the authority to insist on some such precautions against those unsightly defects, and if he does not incorporate some such features in his specifications. neither the contractor or the owner at the present stage of the game can be expected to assume the burden of such precautions, slight though the cost may be.

By Mr. Wason

We have had considerable experience with this trouble and I think that it can be easily explained and overcome. In addition to occurring around posts, hydrants and the like, we find it in connection with area gratings, trap-doors, or any other iron frame embedded in concrete, and it is due to the unequal expansion and to rapid changes of temperature. For instance, if the sidewalk has been cold for a long period and then there is a sudden and considerable rise of temperature, the metal will absorb heat and expand very much faster than the larger body of concrete. This produces stresses in the concrete which cause the cracks. To avoid this, a thin open joint should be left around the post or the hydrant or the grating in the sidewalk, to allow for this expansion, and further, the concrete immediately around should be reinforced so as to prevent cracking.

In regard to corroded metal, iron rust occupies a greater volume than solid metal and if rust forms its expansive force will crack the concrete and if corrosion still occurs, increasing the volume, the cracks will continue to enlarge. I have not experienced any damage to the concrete caused by the rust through chemical action, but merely through its physical action of expansion.

By Mr. Howes

The splitting of concrete is generally due to expansion and contraction, to heat and cold, wetting and drying, and sometimes to a general swelling of the mass during the progressive crystallization. I have known long sections of sidewalk gradually to creep down-hill as the result of the alternating expansion and contraction. When the section expanded it would push the forward portion down-hill and when the section contracted it would draw the up-hill section after it. It is customary in laying fine sidewalk work such as vault lights, to specify that there shall be an elastic, self-sealing composition in the joints, of expansion width between the slabs, and in permanent constructions such as building wall, curb, hydrant, or posts. From the description quoted, it seems doubtful to me that the cracking and splitting can be due to corrosion of metal.

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[6] The Philip Carey Mfg. Co., Cincinnati

By Mr. Case

I am of the opinion that this may be traced to one of three things, viz., vibration of the post, expansion of the post from heat, or enlargement of the post by corrosion through the portion embedded in the cement. We might possibly add another cause, viz., shrinkage of the concrete in hardening. While I have not had anything of this sort in my experience, yet I am of the opinion that the remedy lies in placing some flexible material around the base of the post to act as a cushion, such as mineral pitch, sand or even heavy tar-paper.

As for disintegration following the cracks, I am of the opinion that owing to water finding its way into them and then freezing, the cracked portions will eventually be ruined and require replacing. I find it good policy to provide expansion room between concrete and any fixed object such as a telephone pole, stone walk or Telford in the highway. I know of some cases in which a bridge over open street ditches and abutting Telford on street end and stone walk on yard end has buckled and broken at or near the center.

By Mr. Bennett

The cause of the splitting of sidewalks would be that the posts were firmly embedded in the ground to a depth sufficient to overcome the action of frost, while the sidewalks were possibly laid without regard to frost action in such a manner that they heaved up on this account.

Our practice here in Hartford has been to put in at least 3′ of porous material underneath the concrete sidewalks in order to secure a permanent surface for the walks.

The effect of cracking of the concrete to any great distance around a corroded post would be very small.

Effects of Metal-Bearing Aggregate on Concrete ☐ ☐ ☐

Discussed By H. F. Robinson[1], Rapier R. Coghlan[2], W. W. Berry[3] and W. J. Douglas[4]

"I would appreciate knowing the experiences of others regarding trouble from the use of broken stone containing traces of copper, nickel, iron and sulphur when used as an aggregate in concrete. In some instances, when subjected to the weather, the concrete seems to go all to pieces."

By Mr. Robinson

No direct observations have been made by the writer on the disintegration of concrete due to the constituents of the aggregate from the use of broken stone containing traces of mineral, which according to the experience of some, "goes all to pieces" upon weathering.

In one section of the Hopi Indian reservation in northern Arizona, all of the exposed rock over a large area is a sandstone, quite soft and more or less impregnated with iron, and in some cases containing nodules of iron. This stone when used as a building material slowly disintegrates from weather action and especially if exposed to moisture. There is no gravel in the entire section of country.

An experiment was made in using this stone for the construction of a number of water tanks. They were laid up in cement and plastered on the inside with a cement mortar, well troweled. The moisture from the water in the tank and the weathering combined affected the stone to such a degree that at the end of the first year most of the tanks were worthless for the purpose constructed. An effort was then made to use the best and hardest of this stone for aggregate in concrete, extreme care being taken in the selection of the aggregate, in the mixing and placing. The concrete tanks lasted much longer than those of stone but eventually they too disintegrated until practically worthless. Tanks of galvanized steel have been substituted with the best result.

It is not considered that the trace of iron in this sandstone was the cause of the disintegration of this stone or of the concrete made from it, or that it had any action whatever, but rather that it was caused by the action of the water, which carries a trace of alkali, which was absorbed by the porous stone, together with some frost action. While the winters are not extreme it is believed that the frost action on the wet stone was, perhaps, the main cause of the lack of success in using this material.

It does not seem that aggregate of a hard, broken stone, carrying a trace of iron, copper, nickel or sulphur should cause the disintegration of concrete of which it is a part, because of this mineral content. If the disintegration is caused by a chemical action between the cement and the mineral, the same or a similar action should be present in reinforced concrete, between the reinforcement and the cement, or in the use of cement plaster to cover structural iron work, as is the common practice.

Before laying the blame on the trace of mineral, experiment with the stone by exposing it to the weather, dry, alternate wet and dry, immersed in water to be constantly wet, and if possible, to frost action. If there is no disintegration due to this treatment, then look for chemical action in connection with the cement; but it is probable that the "going all to pieces" will be found in the stone itself, uncombined with the cement.

By Mr. Coghlan

No experience has been accumulated by the writer regarding the subject. From a theoretical standpoint it would seem probable that the presence of copper, nickel or iron in the metallic form might lead to the ultimate disintegration of concrete if they were present in the aggregate. Take metallic iron as a case. It has a molecular weight of 56 and a sp. gr. of 7.25 to 7.79. The change through oxidation to Fe_2O_3 with a molecular weight of 160, and a consequent increase in volume lowers the sp. gr. to an average of 5.25. It seems quite probable that such a change would be sufficient to cause an expansion in the concrete that would disrupt the bond between the cement and sand and rock. Or what would more likely occur would be the change to the carbonate $Fe\ CO_3$ with a molecular weight of 116, and sp. gr. of 3.8, an even greater expansion.

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[1] Supt. of Irrigation, U. S. Indian Irrigation Service, Albuquerque, N. M.

[2] Mfg. Cement Chemist, U. S. Reclamation Service, Dept. of Interior, Elephant Butte, N. M.

[3] C. E. & Supt. of Const., War Dept., Office of Constructing Quartermaster, Fort Huachuca, Ariz.

[4] Barclay, Parsons & Klapp, Cons. Engrs., N. Y. C.

The case of the other two metals is analagous. The remedy would seem to be in having the concrete thoroughly proportioned and as dense as possible, so that the entrance of air, or gas-laden water would be reduced to a minimum. With regard to sulphur, the only possible effect is the change in the crystalline form. It might change under pressure from the octahedral form with a sp. gr. of 2.07 to the prismatic form with a sp. gr. of 1.957, which indicates expansion, with the usual result.

None of the four metals has any direct effect on Portland cement as such, the theoretical effect seeming probable being that due to the lowering of specific gravities through molecular changes.

By Mr. Berry

Nearly all of the minerals containing sulphur are of a medium hardness only, while some have planes of cleavage along which the stone is easily broken. Either of these defects would in themselves be cause for their rejection as an aggregate for good concrete.

There is another and more important reason when it comes to reinforced concrete; that is the action of sulphur on steel and the action of one metal against another in the presence of moisture, acids or alkalies, or the presence of small, stray electric currents. No one need be told of the result of even a slight formation of rust on reinforcing steel once it is in place.

Then concrete is supposed to be fireproof, yet the presence of a sulphide would no doubt when heated form a gas that would be serious in case of a hot fire.

Some time ago neat briquettes were made with a 2% solution of sulphuric acid. In comparison with briquettes made with water those made with the acid were 80 lbs. lower in tensile strength in 24 hrs. and 150 lbs. in 9 mos.

Six months ago a small catch-basin and dam, containing in all not over 5 cu. yds. of concrete, was erected at Garden Canyon, Ariz. When the concrete was nearly all in place one of the workmen called the foreman's attention to a green discoloration of the toools left in the water above the dam. An experiment showed that a shovel would inside of 30 min. be covered with a copper sulphide green if left in the water. This water had been used for the concrete and the sand and gravel had been obtained from the creek bottom. It was noticed that the concrete was very slow in setting but otherwise it is apparently normal.

This however would not cause the writer to put anything in a permanent building but the very best materials. For there is no use spending money for good cement, forms, and labor and then running a chance when it comes to aggregates.

By Mr. Douglas

I have never had any trouble with the ingredients mentioned above nor do I know of anyone who has. I think the reason for not having trouble of this kind is that almost everyone is over particular, if anything, in the selection of the aggregate and that no one ever thinks, so far as I know, of using iron pyrites or other ingredients containing sulphur. While I am not a chemist, it is obvious to me that such constituents are detrimental and should not be permitted unless backed up by precedent.

I have recently received a letter from one of our associates in South America who writes as follows:

> One of the difficulties we are up against is the presence of large quantities of gypsum in almost all materials. We also use certain quantities of mine rock which contains copper sulphate and some free sulphate; the latter dissolves in the wet concrete and if gypsum is present, dissolves it also. There is not, however, enough of this to affect adversely the quality of the concrete.

Placing Concrete Under Water

Discussed By W. M. Kinney[1] C. W. J. Neville[2], Hunley Abbott[3] and E. B. Van de Greyn[4]

"Is it necessary to follow any specific method in placing concrete under water?

"In order to keep down the amount of water, is it detrimental thoroughly to mix the ingredients dry and place them without adding water?

"Is it detrimental to place concrete as above in water which would contain 1/4 part of sulphuric acid in various forms, together with petroleum oils?"

By Mr. Kinney

In depositing concrete under water the work must be done in such a manner that the ingredients will not be separated. To secure this result the methods involve either a tremie, that is, a large pipe through which the concrete is carried to a point near the bottom of the water, the pipe being gradually withdrawn as the concrete is built up, or the use of large buckets by which the concrete is lowered and dumped at the bottom of the water. The best results are obtained by mixing a limited amount of water with the concrete before placing, although when depositing by means of a pipe or chute the concrete is often mixed very dry. In 1907, 1908 and 1909, more than 100,000 cu. yds. of concrete were deposited under water in connection with the construction of the Detroit River tunnel. Tremies were 12″ in diameter and 80′ long.

The difficulty which is often encountered in placing concrete under water usually results from lack of care to prevent the separation of cement and aggregates. If the concrete is thrown into the water or even allowed to settle through it, the separation of materials is unavoidable.

One common and inexpensive method is to provide a closed rectangular wood chute or a circular metal one. This chute is placed with one end extending into the water and to the foundation, in such a manner as to prevent concrete from flowing out while the chute is being filled with concrete. When it is entirely filled it is raised slightly, thereby permitting the concrete to flow out and to distribute itself gradually, at the same time permitting additional concrete to be placed in the chute, so that at no time can water enter. In large work a closed bucket with a hinged bottom is often used. When the bucket reaches the bottom of the foundation, the hinged bottom is released and the concrete falls into position.

In some cases concrete has been placed in sacks which were lowered through the water to the bottom of the foundation, but this does not always result in a good bond between the different parts of the foundation and the method is seldom used. Using a chute is preferable in most cases.

When the concrete is to be deposited from an air-tight receptacle lowered into the water, it should be mixed dry enough so that when the gate or trap door of the bucket is opened, the material will be discharged in a mass.

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[1] Engr. in charge Inf. & Insp. Bur., Universal Portland Cement Co., Chicago

[2] Gen'l. Contr., New Orleans

[3] Vice-Pres. and Chf. Engr., MacArthur Concrete Pile & Foundation Co., N. Y. C.

[4] Cons. Engr., Houston, Texas

It is not the intention of this discussion to give definite instructions which may be followed in any particular piece of work, but simply to outline the procedure which must be followed in work of this nature.

The following is extracted from the *Contractor* for Apr. 1, 1912, and will no doubt be of value in determining the requirements on work of this nature:

> Concrete may be deposited successfully under water if handled so as to prevent the washing of the cement from the mixture.
>
> Cofferdams should be sufficiently tight to prevent current through the pit, and the water in the pit should be quiet.
>
> The concrete should be deposited in place by means of a drop-bottom bucket or a tremie and should not be allowed to fall through the water.
>
> Where a tremie is used it should be kept filled with concrete up to the top of the water level and the discharge end should be kept buried in the freshly deposited mass to prevent emptying and raised a few inches at a time as the filling progresses.
>
> Where a bucket is used, it should be carefully lowered to the bottom and raised to the surface so as to cause as little disturbance as possible of the water.
>
> The surface of the concrete must be kept as nearly level as possible to avoid the formation of pockets which will retain laitance and sediment.
>
> Where concrete is not deposited continuously all sediment should be removed from the surface of the concrete by pumping or otherwise before depositing fresh concrete.
>
> The concrete should be a 1:2:4 mixture of a "quaky" consistency.

Although the expression "water which would contain ¼ part of sulphuric acid in various forms" is ambiguous, we assume that the intended meaning is a percentage of sulphuric acid sufficient to prevent satisfactory hardening of the concrete. Of course, concrete should never be deposited under such adverse conditions.

If the concrete is deposited in accordance with the suggestions already made in this discussion, the concrete deposited below the surface of the water will not come into contact with petroleum oil which may be floating upon the surface of the water. Consequently that portion of the question does not appear to require discussion in this place.

By Mr. Neville

It has been my custom to use a steel tube about 12″ in diameter in placing concrete under water. This tube extends to within a short distance of the bottom of the form and is raised as the depositing of the concrete progresses.

It is also my custom to use a very dry mix, putting in only sufficient water to make the material plastic. Concrete of course should not be dropped any distance through the water as the cement and sand will be washed away from the stone or gravel and the material will settle in layers, the stone or gravel at the bottom, the sand next and the cement on top. My theory of placing concrete under water is that the concrete should be placed so rapidly and in such large volumes that the exterior water will not enter largely into the mass of the concrete but will simply be displaced by it.

I have never had any experience in placing concrete in water containing acid or oils; but as cement is decidedly alkaline in its properties it would appear to me that the acid would tend to neutralize this alkali, to the detriment of the strength of the concrete. Also if steel reinforcement is used in the concrete it should be remembered that it is these alkaline properties of the cement which prevent the steel from rusting, and if acid is present in the water it would be more than probable that this preservative effect of the cement would be destroyed and the reinforcement would rust out in a short time.

By Mr. Abbott

Answering the second question, I believe it would be unwise to deposit in water any concrete which has been mixed up completely dry. When in this state the contained cement is a powder, which would easily float off and separate from the sand and stone, whereas if the concrete has been mixed with the addition of water, the cement has formed a mortar with the sand, and is thus much less liable to become separated from the ingredients than it would be if it were in the form of a powder. Personally, I would not permit the placing of concrete in water under the conditions mentioned in this question, but if the concrete is mixed with water in the proportions known as a rather dry mixture, as opposed to a wet mixture, I believe it could be deposited through 2′ or 3′ of water without damage.

By Mr. Van de Greyn

(1) A method whereby a concrete of good and proper quality can be obtained can of course be used. The greatest danger in placing is segregation of constituents. Lines of weakness due to laitance or other causes should also be guarded against.

Several methods are in use, depending on conditions. For example, the writer was recently asked whether or not, where there was depth of water of not more than 12″ or 24″, it would be safe to deposit a batch of concrete at one end of a pier base, thus forming an island, and then gradually work toward other end. The answer was in the affirmative. As the concrete was deposited on top of and near the advancing end of concrete just previously laid the pressure naturally causes the mass to flatten and advance slowly, occasioning no wash. Where water is deep this method could not be used.

Concrete is deposited under water in several ways, such as in paper bags or open cloth bags, through pipe tremie and by boxes properly built to dump concrete after being lowered to bottom. Very commonly it is deposited by means of concrete buckets with trip-line arrangement whereby the catch on the bottom of the bucket is released and the concrete flows out when the bucket is raised. It may be said in general that on each job some one method is the best. The proper method may be determined by physical conditions, by the size of the job, or by some other condition. For example, where concrete is to be placed about a cluster of piles which are close spaced, in such case there will be loss of time in lowering the bucket so as to miss the piles, or the piles may be too closely spaced to allow an ordinary sized bucket to be lowered between them, making a special size bucket necessary if it is to be used. Where it is considered essential that the concrete clutch the piling I would hardly hardly care to risk the paper or cloth sacks. In the above example a pipe tremie would be best. Consider the job which is too small to warrant much equipment. In such case, it might be best to use the cloth or paper sacks filled with concrete as this could be done with little outlay. If for some reason it is not desirable to use them, then a tremie may be rigged up at comparatively small cost.

(2) This should not be done. The result will pretty surely be a poor concrete. The chances are great that there will be a segregation of the materials and that the concrete will not be compacted and it will therefore be porous. You have all seen concrete mixed by hand where all the materials are sometimes mixed dry before water is added, and it is only after the mass is worked thoroughly after water is added that it is judged to be in proper condition to be put in place. It is necessary that the cement paste coat the sand grains and that the resultant mortar coat the particles of stone and fill the spaces between the stones. This, in my judgment, would not be accomplished if a dry mix were placed under water. Examination of concrete placed by tremie method in-

volving use of wet, rich concrete, has always disclosed it to be dense and well mixed; the loss in cement due to using the wet mix is made up by the use of extra cement in mixing.

(3) The following is quoted from Taylor & Thompson's "Concrete, Plain and Reinforced."

> Experience shows that after concrete has thoroughly hardened it resists the attacks of diluted acids, such as are found in sewage and that it is only seriously affected by strong acids which injure nearly all other materials. Concrete has proved to be the most successful lining for digesters in pulp mills where sulphurous acid is present under high heat pressure; also tests indicate that mineral oils do not injure concrete even if applied when only a week or two old.

One-quarter part of sulphuric acid I would by no means consider a comparatively dilute acid. A piece of hardened mortar about the size of a large hickory nut was placed by me in a solution of 1 part of c. p. sulphuric acid, and 3 parts of water. For about 1 min. there was a decided action on the mortar. It was left in the solution and has been slowly disintegrating.

A general statement regarding proper procedure where water contains impurities, such as acids, etc., could be of no value or safe; each individual problem should be studied and any tests necessary should be made before deciding on the method and kind of construction and materials to be used.

Oil-Proof Reservoirs of Concrete □

Discussed By Wm. M. Kinney[1]

"About a year ago we constructed a reinforced concrete reservoir, 30′ x 30′ x 9′ deep with 12″ thick bottom, top and walls, and used an integral waterproofing in the concrete. The walls are fairly smooth inside and as the reservoir is built between building walls, it will be impossible to oil-proof same from the outside. The reservoir while 9′ deep, will be filled only to a depth of 8′ with crude oil, in which case the top does not need to be oil-proofed. After this reservoir was built, we filled same with crude oil and it leaked very badly. This also means that the walls are fairly well saturated with oil.

"Later we were led to believe that the only remedy would be a steel tank, which we had built inside of the concrete reservoir. This also failed us, in that it leaked oil just as much as the concrete reservoir.

"We are now prepared to take out the steel tank, if it is possible for us to secure any information which will assure us that the present reservoir can be made oil-proof."

By Mr. Kinney

In the particular case referred to there is only one remedy; tear out the steel tank and construct a new concrete tank inside of the defective one. The question then presented is: *"Can a concrete reservoir be so constructed that it will be permanently oil-proof?"*

So far as the effect of oils on concrete is concerned, the general conclusion, based on the results of tests and actual experience, seems to indicate that mineral oils (under which head may be classed lubricating oils and gasoline) show only a slight tendency to soak into the concrete and perhaps reduce its strength somewhat. The extent of this action, however, depends largely upon the quality of the concrete.

Several engineers have made investigations of concrete structures subject to the effect of engine oil and the like and have found that in the few cases where there was any evidence of disintegration the concrete itself was of poor quality or the workmanship was inferior. If the concrete exposed to the mineral oils is porous, injured by frost while hardening, of a lean mixture, poorly mixed or improperly cured, there is no doubt that general penetration and weakening of the concrete will result. If, however, the concrete is made of well graded materials, properly proportioned, mixed and placed so as to obtain a dense, compact mass, the oils will have no destructive effect on the concrete.

A concrete tank built in San Antonio, Tex., is reported in *Engineering Record* of May 30, 1908, as having at that time been in service for three years, holding heavy Texas oil, without showing any leakage whatever.

In *Engineering News* of July 4, 1907, is reported a concrete tank for fuel oil which was built for the Tonopah Mining Co. at Millers, Nev. The tank is built with the top flush with the ground line or a few inches above it in order to prevent any drainage running into it. The inside dimensions are 84′ 6″ long, 35′ wide and 8′ deep, the capacity being approximately 145,000 gals., or 4,700 bbls. The walls of the tank are 4″ thick and the sides and ends of the tank slope in an angle of 60° with the base. A rim around the upper periphery is 12″ x 12″. In mixing the concrete, great care was taken to prevent broken stone larger than $\frac{3}{4}$-in. from entering the mixture, in order that seepage of oil might be prevented. The mixture used was 1 part cement, 1 part sand and 1 part broken stone. Reinforcing bars were use at the inner sections of angle corners only.

In *Engineering News*, Vol. 57, No. 1, p. 12, is descrbied an experiment made on the use of concrete tanks for storing fuel oil. One tank was made and filled with oil and at the end of nine mos. the tank was absolutely tight, the oil having penetrated and discolored the concrete less than $\frac{1}{2}$″, and the concrete remained apparently sound and uninjured.

Several tanks for storing Texas oils have been constructed by the different railroads at El Paso, Tex. A letter from the El Paso & Southwestern System states that it has used concrete tanks to store crude oil uninterruptedly for five years and finds that the concrete has not been injured in any way.

The San Antonio Gas & Electric Co., San Antonio, Tex., has constructed a tank for storing heavy oils, and its superintendent states that after three years' use the tank shows no sign of leakage or deterioration.

Four reinforced concrete tanks for the storage of oil were built in the fall of 1910, for the Queen City Oil Co., Toronto, Ont., Can., at its West Toronto yards. These were for the storage of the lighter products of petroleum. The inside dimensions for each tank were 21′ 6″ wide, 38′ long and 9′ 6″ high. They were placed underground and a cover of 3′ of earth placed on top of them. These tanks were described in *Canadian Engineering* for Feb. 16, 1911. The only precautions taken were to obtain a dense concrete and avoid joints and seams. Immediately after stripping the forms, cement grout was applied on the green concrete.

We would suggest a 1:2:4 concrete, made up of 1 bag of cement, 2 cu. ft. of clean, coarse sand, and 4 cu. ft. of well graded, durable crushed stone or gravel varying in size from $\frac{1}{4}$″ to $1\frac{1}{2}$″. The concrete should be mixed with sufficient water to give a wet, quaky consistency. It is not necessary to mix any oil-proof or waterproofing compounds with the concrete, if care is taken to obtain a dense, impervious surface by proper proportioning, mixing and spading of the concrete near the face of the wall. As an extra precaution, the inside of the tank may be brushed with a mixture of cement and water of about the same consistency of cream.

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[1] Engr. in Chg., Information Bur., Universal Portland Cement Co., Chicago

It is very important that the concrete be uninterfered with in its hardening process for a much longer time than is necessary when the concrete is to be subjected merely to water or weather conditions. We recommend that a tank which is to contain oil be allowed to harden from two mos. to three mos. before filling with oil, during which time plenty of water should be used to assist the hardening process. The Standard Oil Co. is using many concrete tanks for the storage of its oil products, and there is no reason at all why concrete should not be used in the construction of oil tanks, if precaution is taken to allow the concrete to have an unusually long time in which to obtain its full strength before the oil is put into the receptacle.

Oil will not penetrate through a tank of concrete if it is properly constructed and the concrete has been rightly proportioned. Concrete oil tanks are in use extensively throughout Texas and the Southwest. The C. M. & St. P. Ry., the A. T. & S. F. Ry. and the Standard Oil Co. all use concrete oil tanks for storage purposes. *Engineering Record* for Sept. 2, 1911, contains a report from the various division engineers of the Santa Fé R. R. Co., regarding the concrete oil tanks on their divisions. All the reports show that concrete was entirely satisfactory, and the greatest depth to which oil penetrated was reported to be 1½″.

Editorial Discussion

In answer to the above question, so far as we know, there is no product manufactured today that will be suitable for the tank in question, and it is doubtful that it will be possible to develop a product that will answer in view of the fact that the concrete walls have become thoroughly saturated with oil, making it extremely difficult to apply a surface that would adhere for any length of time.

In the particular case referred to there is only one remedy, i. e., tear out the steel tank and construct a new concrete tank inside of the defective one.

Putting New Top Finish on Old Floor Base

Discussed By Leonard C. Wason,[1] A. M. Wolf[2] and W. M. Kinney[3]

"We are a little in doubt as to how to proceed in putting on a new top surface of a terrace in connection with a large residence. The floor of the terrace is of a reinforced, 1:6, concrete mixture and over the top of this was originally laid a composition flooring material, composed largely of wood fiber and cementitious binder, the nature of which we do not know in detail. Before this material was put on the surface of the concrete base was treated with a solution intended to fill up the voids and prevent an attack by moisture coming through the concrete to the under side of the composition material. This is an exterior job, of course, and the floor has been unsatisfactory. Just how should the work proceed in putting on some new finish, such as terrazzo or grouted tile?"

By Mr. Wason

I do not consider that this type of floor covering is suitable for outside work. The principal concern laying it in Boston does not recommend it where there is much moisture. In spite of adverse judgment, I laid this in my garage over a wood floor and where wet it expands and blisters and finally breaks when one steps upon the blister. For repairs, I should entirely remove this from the old base, cleaning dirt and dust away, and make a new finish; if of terrazzo or grouted tile, have a total thickness of at least 2″. The base would be about 1½″ of good concrete with fine aggregate on which the terrazzo would be spread and worked in before the base set, or if tile is used, use a base of about the same thickness on which the tile is bedded and joints grouted full as fast as laid. Then the work should stay down and give permanent satisfaction.

By Mr. Wolf

The question as to the best method to use in replacing a new top finish on an old reinforced concrete base of an outside terrace is an important one and closely allied to the problem of applying finish to interior floors where the base and the finish are not put down at the same time.

In the writer's opinion the old top finish should be removed entirely so that no traces of it remain, then the top of the concrete base should be thoroughly cleaned off and washed, and the surface roughened by picking and washing with a strong solution of hydrochloric acid and water. All traces of the acid wash should be removed before the new top is put on, by thoroughly flushing off the surface with fresh water.

If any cracks are found in the base, the concrete adjacent to them should be chipped out, the loosened particles removed, the concrete thoroughly wetted, a grout wash applied and the base brought up to the surface with fresh concrete which has been mixed for about 10 min. to 15 min., or such time as would be required to make the mixture very close to what might be called a retempered mixture.

After the base has been repaired it should be flooded with water and as much as possible allowed to soak into the slab. A light wire mesh or welded fabric with meshes about 4″ x 4″, the wire being about 12-ga. or 14-ga., should then be spread over the base with a 4-in. lap at side and ends where splices occur. The wire mesh is specified for the reason that it reinforces the mortar coat and thereby makes it better able to withstand the temperature stresses which arise in slabs exposed to sudden changes of temperature, such as a terrace covering of this kind.

Upon this mesh spread a 1½-in. layer of 1:3 mortar as a bedding for the terrazzo or tile. This mortar should be mixed rather wet to allow for a certain amount of absorption by the old base. If possible this work should be done in damp and cool weather with the temperature not much over 60° F. This will tend to eliminate rapid drying out of the mortar coat and attendant contraction cracks. The entire surface should be kept damp and protected from the sun and wind for at least 1 wk. after placing.

By Mr. Kinney

In the first place, the old top finish must be removed and all dirt and debris swept from the surface of the slab forming the base for the floor surface. This surface should then be roughened thoroughly and cleaned in a manner that will expose the surface of the aggregate free from mortar, or cement. If an acid wash is used, all traces of the acid should be removed by scrubbing the floor thoroughly with clean water, preferably applied through a hose. The slab should be soaked thoroughly with water and kept wet for 24 hrs. before the new wearing course is placed.

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[1] Pres. and Mgr., Aberthaw Constr. Co., Boston

[2] Civ. Engr., Condron Co., Chicago

[3] Engr. in Charge Insp. and Inf. Bur., Universal Portland Cement Co., Chicago

In applying terrazzo finish, the surface of the slab should first be carefully treated with a neat cement grout, brushed on, and immediately following the cement grout a layer of ½" of cement mortar, composed of 1 sack of Portland cement to 2 cu. ft. of clean, coarse sand, should be placed. This should be spread perfectly level with a straightedge. On this the terrazzo mixture may then be laid and the work proceed in the customary manner. If the new wearing surface is to be of tile, the same kind of mortar bed should be used, put down as already described.

The Proper Use of Steam in Curing Concrete Products

DISCUSSED BY WM. M. KINNEY[1] AND E. L. CONWELL[2]

"What is the advantage, in the operation of a steam room, in conducting steam through a trough of water in the floor of the room? If it is true that moisture in steam begins to condense as the temperature is lowered, it would naturally seem that the introduction of steam into water would tend to remove some of the moisture from the steam before it could escape into the curing room to be deposited on the concrete products. I should think that if the steam room is not steam tight, and the steam not under pressure, there would be no danger in allowing the steam to escape direct into the room, providing the steam were fairly well diffused on its escape from the supply pipes."

BY MR. KINNEY

The principal object in steam curing concrete products is to accelerate the hardening by means of heat without endangering the concrete through loss of moisture by evaporation. Saturated steam will not only provide sufficient heat, but moisture to insure against injury from drying.

In the early history of concrete products manufacture it was customary to use exhaust steam for heating the curing-chamber; but as a sufficient quantity of steam could not always be procured, the natural resort was to use steam direct from the boiler. Records show that in many cases large quantities of good concrete came to grief, owing to some drying action, which at that time was not explained.

Especially difficult is the maintenance in a boiler of a sufficient quantity of steam at low pressure to heat properly any number of curing rooms. Coupled with this difficulty is the danger that pressure will rise considerably above that necessary to supply the steam required for proper curing. With this in view we have been recommending steam under pressure; that is, up to 30 lbs. or 45 lbs., provided it be admitted through water.

The most satisfactory way of admitting steam in this manner is through a perforated pipe embedded in a trough of water running through the center or along the sides of the curing chamber. The floor should be so sloped that any water or condensation on the products or on the walls of the curing chamber will be returned to the trough for re-evaporation. In this manner the trough is automatically kept full of water, and we have yet to record a case of trouble when this method of curing was employed. All of the heat which the steam contains on being emitted from the boiler is at once taken up by the water, and the result shown by evaporation. The temperature of the water is at the boiling point, owing to the fact that steam is continually being forced through it, and what heat is taken up by the water is used in causing evaporation. Water evaporated at 212° F. is just as useful in warming the room as is steam at the same temperature.

To explain the drying action of steam under pressure as admitted to the curing chamber, let us assume that we are taking steam from a boiler operating at 30 lbs. gauge pressure. The temperature of the steam in the boiler is 272°. Upon opening the valve, the steam is reduced to 252° and atmospheric pressure. It is, of course, understood that steam under atmospheric pressure and having a temperature of 252° is in an abnormal condition in that there are 40° of superheat present. This steam is in a similar condition to that which would be obtained if water vapor at 212° were heated up to 252° away from contact with water. Naturally the first thing that steam in this condition does is to avail itself of the first opportunity to reach normal conditions, and the easiest way in this case is to absorb water from anything in its vicinity. The result is a drying out of the concrete products which happen to be stored nearest to the superheated steam.

BY MR. CONWELL

The advantage derived from curing concrete products by introducing steam through water is by no means clear to me. From general knowledge of the use of cement, quite the reverse would appear to be the case. Certainly a great proportion of the steam would condense into water and while this would raise the temperature of the water to a point close to boiling, it would perhaps increase the humidity of the air in the curing chamber. I think that the direct introduction of steam would cause a greater humidity in the atmosphere and in addition would raise the temperature of the room somewhat. The setting and hardening processes of Portland cement are merely chemical reactions and while they are as yet imperfectly understood, it is nevertheless true that in common with all chemical reactions, the rate at which they take place is accelerated by heat and retarded by the absence of heat. It is, therefore, to be expected that the introduction of steam in addition to furnishing the concrete products with more of the water which they require for hardening, would hasten and accelerate the hardening action through raising the temperature. The influence of steam in accelerating the hardening of concrete is well illustrated by the custom in testing cement of exposing a pat of neat cement to steam in a loosely closed vessel for several hours. This is the accelerated test to develop unsoundness if it exists in the material. But all who are familiar with the practical details of this test know that the pats, after a few hours' exposure to steam, become extremely hard. It is also quite well known that a neat cement briquette which has been exposed to steam for several hours will show more strength than a corresponding briquette of the same age which has not been so treated. Another somewhat analogous process to curing of cement by steam is the manufacture of sand-lime brick. It is of course true that in the sand-lime brick cylinders the steam pressure is carried to as high as 150 lbs. per sq. in. in some cases, but the materials used in sand-lime bricks are relatively difficult of attack by steam, while Portland cement is so unstable that it sets and hardens when mixed with water at ordinary temperatures, so that the influence of steam at 5 lbs. to 15 lbs. pressure on concrete products should be very marked.

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[1] Engr. in Charge Insp. and Inf. Bur., Universal Portland Cement Co., Chicago

[2] Vice-Pres., Henry S. Spackman Engrg. Co., Philadelphia

It should be understood by anyone curing concrete products by the direct introduction of steam that this amounts to the performance of the test for unsoundness on Portland cement, and if a cement is used which is not sound, this method of curing would probably cause disintegration of the concrete products. A good suggestion, therefore, would appear to be to test each fresh shipment of cement by making several small pats 3″ in diameter and ½″ thick at the center and tapering to a thin edge. These pats should be exposed to steam for several hours and the appearance of checking, warping or cracking in them would be an indication that the cement should not be used in concrete products to be cured in steam.

Editorial Discussion

While the opinions of Mr. Kinney and Mr. Conwell do not coincide, it seems well to call attention to a safe middle ground in steam curing practice. It has been demonstrated by tests made under the direction of the U. S. Bureau of Standards that under the conditions of the particular series of tests very high strengths have been obtained in concrete products cured in a steam-tight cylinder under a pressure of as high as 80 lbs. Products were not subjected to such treatment immediately after removal from the molds, however. In fact good results required that about 24 hrs. should have elapsed between molding the products and subjecting them to high pressure steam. Such curing methods are yet to be demonstrated as being commercially practical. Until it is further demonstrated that all good Portland cements should withstand a severe test under high pressure steam, good practice would seem to lie in the use either of steam admitted to the curing chamber through water or through a reducing valve, which will keep the pressure down to 5 lbs. Steam at 5 lbs. is being used satisfactorily without the use of troughs of water.

Will Mixing Concrete Too Wet Cause Its Eventual Failure? □

Discussed By Chas. J. Bennett,[1] Theo. Dwege,[2] R. L. Rickman,[3] Leonard C. Wason[4] and Carl H. Fuller[5]

"Will mixing concrete too wet cause its eventual failure?"

By Mr. Bennett

In answering this question I think that the degree of wetness has much to do with the ultimate strength of the concrete. Concrete can be mixed so wet that there will be a separation of aggregates on account of the preponderance of water, that is to say, the heavier particles will sink to the bottom and there will be a consequent loss in strength due to the fact that the different ingredients will not be thoroughly mixed. This condition may take place after the concrete is in position owing to the disturbance of the mass caused by placing and spading the material against the forms, so that it may safely be said that too wet mixing will cause eventual failure of concrete structures.

In further consideration of the topic, concrete which is materially wet will, of course, take a longer time to set than concrete which is properly mixed, so that the time of removal of forms would have something to do with the ultimate failure of the structure; that is, if the concrete were mixed quite wet and the forms removed quickly, the mass would not be thoroughly seasoned and there might be a failure on this account.

The right amount of water to be placed in concrete is not a matter of actual percentages to be stated, because the amount of water to be taken up will vary with the condition and class of mineral aggregate and the brand of cement.

As a rough, general rule, however, concrete should be placed with an amount of water sufficient to allow the foot of a laborer to sink into the mass and to leave a perceptible hole after the laborer withdraws his foot, a hole which will gradually close up but not fill with water.

By Mr. Dwege

I firmly believe that mixing concrete too wet is very injurious, especially in hand mixing where it is not thoroughly mixed again with absolutely clean material which will allow the water to carry off a certain amount of the cement. I believe for this one reason that a certain percentage of loam would retain water and make the concrete set up more slowly, which would be beneficial.

By Mr. Rickman

This might be possible under certain conditions where the forms were not so nearly watertight as they should be, or where the concrete is placed upon a very sandy base from which the water could easily escape in a short time after pouring. While I believe that a great deal of concrete is made too wet for its own good, I think that the greatest harm that may arise from this practice is that the excess of water escapes before the concrete has set up hard, thus carrying off a great deal of the "vitality" of the cement with it.

Where concrete is spread on a sandy foundation, as often occurs in laying sidewalks, floors, etc., the sandy base will quickly suck all the water possible out of the concrete, leaving more or less voids by its disappearance. You might ask: Would not this occur in a mixture just wet enough to quake? I do not think so, because when a flow is once established, the consequent suction is much greater, and establishes what you might term "inverted capillary attraction."

It is well that where a concrete structure has failed from any cause, that we take up the catalog of "probable causes" and discuss them in detail, in order, if possible, that the true cause may be found, together with a remedy.

There are so many causes that may contribute their part in the failure of a concrete structure, that it becomes a very difficult matter to say which one was the "specific" cause.

When a concrete structure fails, it may be said to have "died from unknown causes" until an autopsy has been held, and a careful diagnosis made in an endeavor to find out what caused its demise.

The verdict of the attending "corhands of a mob, who have been identified as:

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[1] Highway Commr., Hartford, Conn.

[2] Contr., Hammond, Ind.

[3] Contr., Eau Claire, Wis.

[4] Pres. and Mgr., Aberthaw Constr. Co., Boston

[5] Engr. and Contr., Corinth, Miss.

"Dirty Aggregate,
"Too Lean Mix,
"Poor Proportion,
"Poor Mix,
"Too Much Water
"Too Little Water
"Too Much Heat
"Old Jack Frost, led by
"Old Don't Give-a-Damn, and his son,
"Don't Care-a-Damn."

"Having ascertained the above facts, it is the judgment of the coroner's court, that "Old don't give-a damn" and his son "Don't care-a-damn," being responsible for the mob's action, they should be at once apprehended and placed in solitary confinement for the rest of their natural lives, as a penalty for abusing the confidence of *innocent parties* and causing their unnecessary and wanton destruction."

I heartily agree with the coroner's decision.

By Mr. Wason

When concrete is mixed too wet and put into tight forms, the water is held in it mechanically until the cement sets. It eventually evaporates, and where the excess of water stood there is a void. This void, reducing the cross-section of the concrete, is a cause of weakness. A large excess of water also is liable, during the placing of the concrete, to cause separation of the materials, the heavy stone settling through the mortar to the bottom, leaving the mortar on top, and to the top of the mortar floats up the lighter material called laitance which if not removed leaves soft, spongy and weak strata in the concrete. These defects weaken the concrete somewhat but are not causes for ultimate failure, because the weakness is not sufficient to cause a dangerous stress in the material.

If we have a 1:2:4 mix with a factor of safety of 4 for its ultimate strength for well mixed and carefully placed concrete of the right consistency, if mixed wet and with improper care there is still likely to be at least a factor of 3, so that failure is not likely to occur. There was an article written by Cloyd M. Chapman, entitled "Waterproofing with Water," published in the *Proceedings* of the Am. Concrete Inst., which shows a variation in strength to different percentages of water. This is a very interesting paper.

By Mr. Fuller

In the earlier days the tendency was to mix all concrete too dry and sidewalk and concrete block people still adhere to that practice, with the result that their products do not attain the strength of the wetter mixtures. Now the tendency, owing largely to the chuting systems of depositing in forms, is causing the pendulum of opinion to swing in the other direction and many contractors are mixing too wet, something that one is easily tempted to do because it facilitates the handling of the material.

Mixing concrete is a chemical process and if sufficient water is not added at the time it is mixed, the cement not only fails to become thoroughly mixed with the balance of the material but from lack of water at the initial moment fails to attain the adhesive strength it should. On the other hand the addition of too much water causes the cement to segregate and separate from the heavier material and this is especially true in chuting systems. The exact proportion of water causes it to adhere and cling to the heavier material until it is all deposited in an even mass in the forms and from its weight the excess of moisture is removed. To get perfect concrete, just enough water should be added to make a thoroughly creamy consistent mixture in which every unit of the heavier material is thoroughly coated with cement and in which the heaviest stones will float and set without settling to the bottom. This kind of a mixture is easy to tamp, does not flow quite so readily in the chutes, requires more mixing and has a tendency to clog the mixer and tools but produces very little sweating or leaking of forms. While I have not had an opportunity to test samples of such concrete for comparison in the tensile and the crushing machines, I am convinced from observations in cutting holes in walls and mass masonry and in the destruction of concrete structures that the evenly mixed concrete is the strongest, and no concrete can be moved from the mixer and deposited in the forms and remain evenly mixed if there is too much water in it.

On any large job, where the operations were sufficiently diversified, any one who knew just what he was looking for and equipped with a good camera would in a few days of watching pick up a number of photographs, the comparison of which would convince any rational minded man that the quantity of water plays an important part in the mixing of concrete. With a dozen or more photographs, such as I have in mind, I believe that I could put up a convincing argument along this line.

Correspondence

Lack of a Standard and Uniform Method of Cement Test Requirements

A Letter From Geo. F. Jenkins[1]

There is one matter that has been to a greater or less extent the source of a great deal of concern to all contractors. That is a lack of a standard and uniform method of cement test requirements.

At present in almost all cases where cement is to be used in any considerable quantity the specifications require a given number of samples to be taken from each car and shipped in sealed packages to the owner or to the engineer's office, in some cases hundred of miles, for formal tests, from one week to two weeks before using. This involves not only a delay to the work for which the cement is intended, but an expense to the contractor either of handling and housing at the risk of rehandling in the event of rejection, or it necessitates, in case of carload shipments, holding the cars under load at the cost of demurrage and service charge pending acceptance or rejection.

Most cement manufacturers provide storage bins at their works where accepted cement can be held for shipment on any special order, but the owners, particularly railroad companies, are not always willing to allow inspection and storage at the mill.

It is possible that if this subject is taken up and discussed through the columns of your publication in your usual forceful manner, it will result in some relief to the contractor and should be of mutual interest both to him and to the owner.

Industrial Canada has just published a report of manufactured articles imported by Canada from the U. S. in the year ending Mar. 31, 1914. Among the imports were nearly $300,000 worth of Portland cement and these figures, which seem quite staggering, and the facts concerning them have not been thoroughly understood. Owing to the late opening of navigation and the difficulty of getting across, a large portion of the Canadian Northwest was left bare of cement for part of 1913 and in order to keep construction going immense volumes of American cement were rushed in to fill the temporary void caused by the conditions mentioned.

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[1] Geo. B. Swift Co., Inc., Gen. Contrs., Chicago

Organizations

American Concrete Institute, Charles L. Fish, Secretary, Harrison Building, Philadelphia, Pa.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager. Chicago Cement Show, Coliseum and Light Infantry Armory, Feb. 12-19, 1916.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. P. Beck, Sec., 208 S. LaSalle St., Chicago.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Of the new uses of concrete there seems to be no end and the latest is in connection with a dummy war fleet which is reported to have sailed to block the Kiel canal and prevent the German vessels from getting out. It is needless to say that this war strategy could not have been brought to a successful conclusion unless cement were used to fill the holds of the vessels and thus lower them in the water. The plan as described was to take a number of old steamships, bought from the merchant service, including ships like the Campania, Oruba and Orotave, which have been fitted with dummy funnels, wooden turrets and guns and their holds filled with cement to lower them in the water. This will make them torpedo proof, it is explained, because, owing to the hardness of the cement, a torpedo exploding would only rip off a plate or two in the hull. An outside belting of cement has been added to the hulls of these dummy warships to protect the engines and boilers. The report of a battle between a German torpedo and a dummy ship loaded and belted with concrete is yet to be made but the result will be awaited with interest.

New Books

Concrete Pile Standards. By Hunley Abbott, Vice-Pres. and Chf. Engr., MacArthur Concrete Pile & Foundation Co., paper, 9″ x 12″, 59 pp., illust., $0.50.

This booklet contains drawings, specifications and other data prepared for the assistance and convenience of engineers, architects, and designers who have to prepare specifications and plans for concrete pile foundations. It is divided into five chapters, i. e., standard details of reinforced concrete pile caps, full explanation of their design and large scale dimensioned drawings showing the arrangement and spacing of piles and the design and reinforcement of pile caps for pile clusters of from one pile to 25 piles, under the assumption that each pile takes a load of 30 tons, with a table giving the thickness of cap required if the permissible load per pile is 35 tons; standard specifications for all types of concrete piles with special clauses referring to pedestal piles, Raysum and lime companies; and statismolded piles; concrete vs. wooden piles (a comparison of costs under various soil conditions); detailed description and drawing showing the method of testing a concrete pile; and the theory of pile support, with actual values for friction and bearing quoted from recognized authorities.

The author has touched on practically every step in the design of concrete pile foundations and much time and expense may be saved by the use of these standards.

Gas, Gasoline and Oil-Engines. By Gardner D. Hiscox, M. E., and Victor W. Page, M. E., cloth, 6″ x 9″, 640 pp., 435 figs. The Norman W. Henley Pub. Co., $2.50.

This is the revised, 21st edition of what has always been a most complete treatise on modern explosive motor design construction, management and application. The present volume defines clearly the elements ofinternal combustion engineering, treating exhaustively on the design, construction and practical application of all forms of gas, gasoline, kerosene and crude petroleum oil engines, and at the same time describing minutely all auxiliary systems, such as lubrication, carburetion and ignition. It also considers the theory and management of all forms of explosive motors for stationary and marine work, automobiles, aeroplanes and motor cycles, including also producer gas and its production.

Robert F. Hall Succeeds J. P. Beck As "Universal" Publicity Manager

Announcement has been made of the resignation of J. P. Beck as publicity mgr. of the Universal Portland Cement Co., Chicago. He will be succeeded by Robert F. Hall, who for several years has been connected with the sales department of the Universal Co. Mr. Beck has been with the company for eight yrs. No statement of his future plans has been made public. He has made a wide acquaintance in the cement and concrete field, especially through his position as manager of the Cement Products Exhibition Co.

Robt. F. Hall, who succeeds J. P. Peck as publicity mgr. of the Universal Portland Cement Co., has spent the last six yrs. in the sales department of the company. He is well known throughout the cement industry because of his activities in its Assn. Mr. Hall is a graduate of the Univ. of Mich., where he completed the Academic course in 1894 and the law in 1895. He is a resident of Chicago, having begun the practice of law there on leaving college, in the office of A. W. Green, now pres. of the National Biscuit Co. He held an important position with that company before going into the cement business with the Universal.

An interesting feature in the use of concrete on the farm is afforded in an address of Dr. Graham, head of the Long Island Agricultural School, to the farmers of the island. In his talk he referred to the fact that from the beginning of the Extension Department, the desire had existed to instill into the minds of Long Island farmers the necessity of up-to-date silos in which the feed will not rot. The concrete silo, he stated, is the only logical receptacle. In order to increase the use of this form of silo, he stated that he would be willing to superintend the erection of concrete silos on their farms, but that when he made the offer, he did not think that 15 acceptances would be received in such a short time. Therefore, he said, he had been compelled to send out an experienced man to show the farmers how to use the steel frames which the school is loaning. Certainly this is an interesting development in the use of concrete on the farm and similar experiences will doubtless await many of the older agricultural schools which proceed in the same direcion.

An Inexpensive Bucket and Hoist for Concrete Handling

By E. H. Owen[1]

The following is a description of an inexpensive "home-made" bucket and hoist for handling concrete in relatively small quantities used by the Bay City Stone Co. in constructing the concrete warehouse for the Jennison Hardware Co., at Bay City, Mich.

The building, designed by Adams & Cummins, Detroit, follows the outer lines of an area trapezoidal in shape, 200′ long, 83′ wide at north end and 140′ wide at south end, and consists of a low two-story reinforced structure of loose rod beam and girder type, 18′ wide on north and west and 24′ wide on east and south, surrounding a center "court" which is covered with a roof of mill construction supported by wooden posts and the inner edge of the concrete roof, and rises above the concrete structure to form a monitor.

The second floor is 9′ 6″ and the concrete roof about 18′ above grade, except on south side where the second floor is 11′ 5″ and roof about 23′ above grade.

A Standard Machine Co.'s mixer[2] driven by a Novo gas engine[3] was placed just inside of the east gallery south of the center line of the building and fed a wooden hopper discharging to wheelbarrows for all foundation work.

The capacity of mixer necessitated 1-bag batches, using bank gravel in the proportion of 1:4½ for floors and roof.

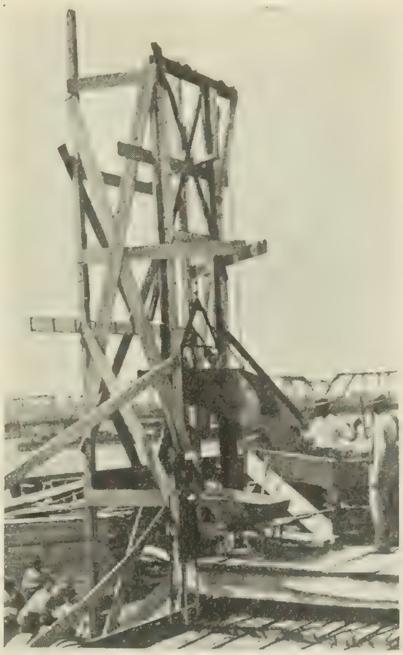

Fig. 1—Self-Dumping Bucket Discharging into Wooden Hopper Above 2nd Floor

Shepper & Covert, Bay City, were engaged to make the self-dumping bucket for use on work above grade but before its completion a start was made on the west gallery by means of barrows and a runway from grade. After four das. using this runway the bucket and hoist were installed over Sunday, the bucket dumping into a wooden hopper above the second floor, which discharged to barrows on runways on the floor, as shown in Fig. 1. A closer view of the bucket is shown in Fig. 2.

The result of the four das. run without bucket has been compared with the six das. run on the same floor with the bucket and the following is noted:

The average rate of placing concrete increased from 3.45 cu. yds. per hr. to 5.45 cu. yds. with bucket, and the labor cost dropped from 82 cts. per cu. yd. to 62 cts. per cu. yd., showing a difference of 20 cts. per cu. yd. for the total of 203.2 cu. yds. poured with the bucket on this floor, itemized as follows:

Second Floor

13 laborers without bucket.

	Yds. per hr.	Labor cost per yd.
5/20	3.4	.83
5/21	3.9	.73
5/22	3.3	.85
5/23	3.2	.88
	4| 13.8	4| 3.29
Ave.	3.45	.82+
6/1	6.1	.59
Delays account showers, etc.		
5/25	4.8	.71
5/26	5.7	.60
5/27	5.5	.58
5/28	5.4	.63
5/29	5.2	.70
	6| 32.7	6| 3.81
Ave.	5.45	.625

1 engineman, 14 laborers with bucket.

Total yds. second floor poured with bucket, 203.2

Labor cost diff. = .20 × 203.2 = $40.64

Saving in time $\frac{203.2}{3.45} - \frac{203.2}{5.45} = 21$ hrs. = 2.3 9-hr. das. at $20 = $46 bonus

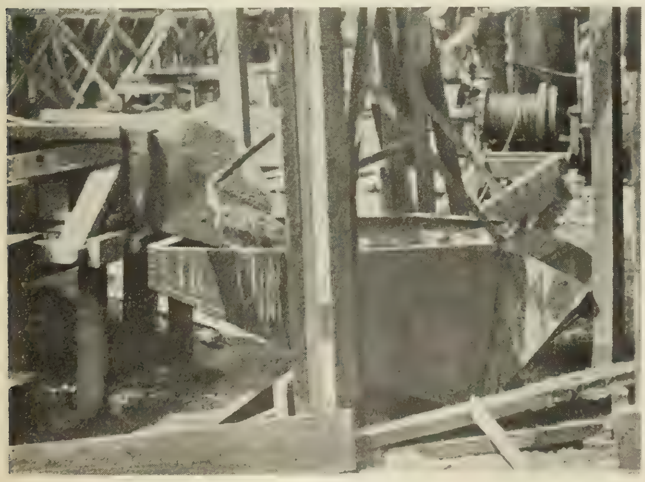

Fig. 2—Filling Self-Dumping Bucket Prior to Hoisting

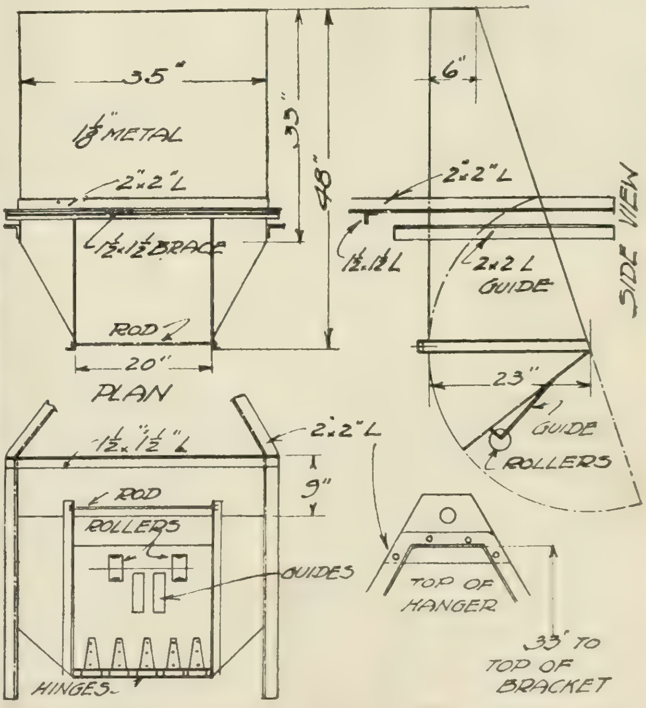

Fig. 3—Sketch Showing Details of "Home-Made" Self-Dumping Bucket

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[1] Asst. Engr., Larrowe Const. Co., Detroit

[3] Novo Engine Co., Lansing, Mich.

The self-dumping bucket and gate for the lower wooden hopper cost $17 and the total cost of materials and labor of building tower, rigging, etc., was $22.60, making a total of $39.60 for this equipment, the items being as follows:

Bucket and gate		$17.00
2 carpenters, 4 hrs. at 37½ cts.	$ 3.00	
2 carpenters, 8 hrs. at 37½ cts.	6.00	
2 carpenters, 8 hrs. at 35 cts.	5.60	
2 carpenters, 4 hrs. at 37½ cts.	3.00	
		17.60
Lumber		3.00
Bolts		.75
Gate for hopper		1.25
		$39.60

Covert said to have lost $5.00 on bucket

No charge is made for use of hoisting engine, sheaves and cable as they were to be used later for other purposes and such charge would be approximately offset by a like charge for partial use of runway before mentioned.

The bucket and hopper were later raised to pour about 200 cu. yds. on the roof.

The saving of time was an important item as the contractors were working under a bonus and forfeit clause of $20 per da. The saving of 21 hrs. or 2.3 9-hr. das. represents a bonus of $46.

In figuring labor cost the time of an engineman for hoister and for one laborer is included in the figures for work with the bucket. Nevertheless, the saving in labor for the 203.2 cu. yds. at 20 cts. equals $40.64.

The sketch of the bucket shown in Fig. 3 is self-explanatory. The bucket ran in plank guides of usual construction in a wooden tower with a plank guide in front of the rollers which guide was provided with steel plates full length stopped off and bent over at proper height to allow the gate to be forced open by the weight of the concrete, and to close automatically as the bucket was lowered.

Very little trouble was experienced with leakage or clogging of the gate, although it can be seen that in this respect the design of the bucket could be improved with little or no additional expense.

The absence of thrust upon the tower usual in the common type of self-dumping buckets was an important consideration in its favor.

In connection with a bill now before the governor of the state of N. Y., authorizing the Borough of Manhattan to make a contract for the erection of a garbage destructor, T. Hugh Boorman has made an interesting suggestion. In discussing a recent paper before the Am. Soc. of Civ. Engrs., he proposes that the ultimate disposition of the garbage shall be in the making of clinker which when properly crushed may be used in the construction of concrete and cement sidewalks. In referring to the subject, Mr. Boorman called attention to investigations of municipal sewage destruction plants in England and stated that it was common practice to make clinker for concrete purposes and that in the Borough of Kensington, London, the municipality used the clinker in the manufacture of asphalt block. Commercially speaking, N. Y. is so advantageously situated for the delivery on the job of the best concrete materials, that it is a little doubtful that municipally prepared clinker from sewage destruction will be as economically available as it would be in a city less advantageously situated with reference to concrete stone distribution. However, if the municipal engineering departments were to decide upon the availability of the material, it would be an easy matter to specify it in municipal contracts and thus provide a ready market for the waste product of the garbage destructor now under contemplation.

Concrete Road Near Columbus, Ohio, with Surface Broomed, Transversely

Difficulties in Construction Cost Accounting

Leslie H. Allen, of the Aberthaw Const. Co., Boston, in discussing his paper before the Boston Soc. C. E., states that one of the great difficulties in construction cost accounting lies in the constant change of work asd change of men on the job. Men who work for a day digging a trench are later transferred to unloading steel or working hand pumps. Carpenters who are placing concrete forms one day in gangs of two or three may the next week be hanging doors or jointing in sash singly. The job may start with 10 men and in 3 wks. be employing 100, increasing later to 150, and then drop to 20, 3 wks. before the job closes. There is no continuity of operation which can be systematized, and as soon as a man has reached efficiency on one operation he is likely to be transferred to an entirely different piece of work. All of this work is done in the open air under varying temperature and weather conditions. For all of these reasons the fluctuations in daily and weekly costs are very great and need very careful watching.

Rat-proofing as a municipal problem for reducing plague is occupying much attention in New Orleans. With its large dock front the Crescent City has for many years been subjected to various diseases disseminated through rats and to obviate and permanently cure this trouble an enormous amount of concrete work has been done along the dock front. Since Oct. 3, 1914, when the records of this class of work were started, 314,000 sq. yds. of concrete at least 3½″ thick has been laid or in other words, enough to build a concrete sidewalk 3′ wide and 178 mi. long. The method used is to cover the ground area of the structure to be rat-proofed to a depth of at least 2′ in the ground and in frame buildings with double walls the foundation wall must extend to a height of 1′ above the floor level except at natural and necessary openings such as doors. Ordinary traps and poisoning have proven ineffective owing to the high birth rate of rats and it would seem that the rat-proofing of the warehouses, buildings, railway sheds and other edifices along the waterfront is the only practical way of accomplishing the desired purpose. This is only another illustration of the many uses of concrete which seems to be proving a remedy for almost all modern ills.

A One-Story Machine Shop at Norfolk Downs, Mass.—Designed for Two Additional Stories

The machine shop shown in Figs. 1 and 2 and described in the following article was constructed for the Pneumatic Scale Corporation at Norfolk Downs, Mass., being so designed that at any time in the future two more stories may be added. The roof of the present building, which will ultimately form the second floor, is perfectly flat, while the coping around the edge represents the curtain walls or wall beams for the second story. Fig. 1 shows the relation of the new building to the previous wooden building, which is partly of one story and partly of two stories.

GENERAL DESIGN

The new shop is extremely light, as shown by Fig. 2. It is built with a flat ceiling, supported by the usual mushroom columns, 18″ x 18″, with mushroom head in the form of an octagon 4′ 9″ in diameter, as shown in Figs. 3 and 4. The net height of the story from floor to ceiling is 15′, while both floors above and below are 8″ thick, of reinforced concrete. The building measures 131′ alongside the previous building, by 90′ in the other direction, and is rectangular.

Because of the swampy character of the site, which is only about 15′ above sea level, the structure rests on 174 concrete piles, 18″ in diameter and about 40′ long. There are four piles under each column footing and three under each wall column, as shown in Fig. 4. The spacing of columns is 17′ 6″ by 18′ 3½″. Each bay around the three open sides is occupied by a window 11′ 8″ high, measured downward from the ceiling line. The whole circuit of these three sides of the building is glass, except for the wall columns, which vary from 26″ to 27½″ in width between windows. The windows are thus 15′ 4″ wide on the two short sides of the building and 16′ on the long side.

Both floors are reinforced by cross and diagonal bands, consisting in each of the four directions of ⅜-in. round rods, 6″ o. c., passing over the center of the interior columns. The interior columns themselves have four 1-in. rods, vertically tied together by ⅜-in. hoops, 12″ apart. The wall columns have similarly six vertical rods, tied together in the same way. These wall columns are 18″ thick, the curtain walls being 6″ and the foundation walls 14″. Both floor slabs have granolithic finish. The coping above the present roof has a height of 2′ 4″.

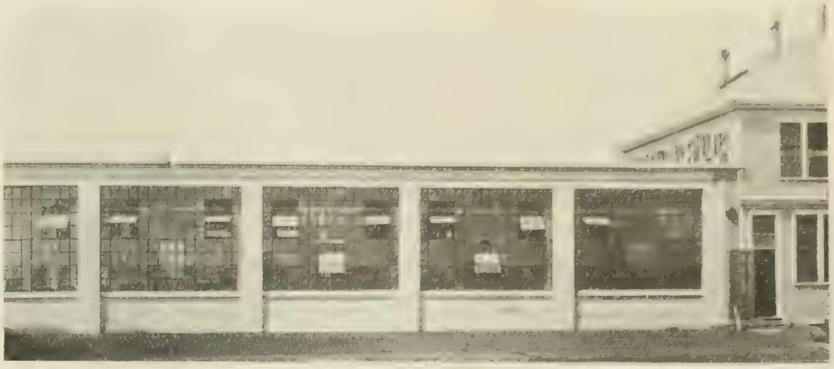

Fig. 1—View of One-Story Machine Shop for the Pneumatic Scale Corporation at Norfolk Downs, Mass.

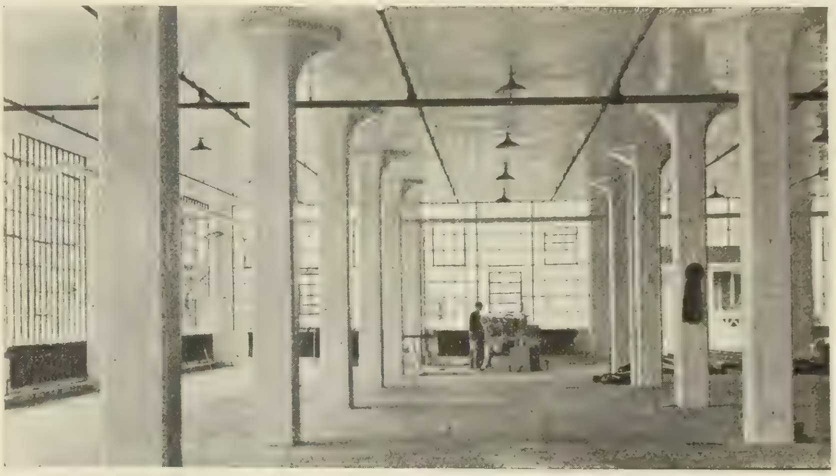

Fig. 2—Interior View of Machine Shop at Norfolk Downs, Mass.

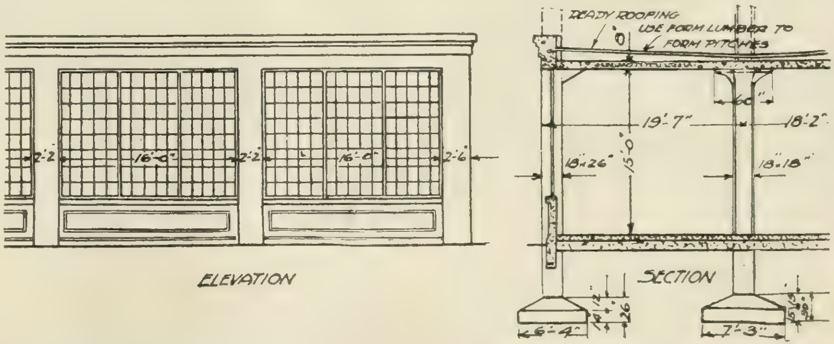

Fig. 3—Partial Elevation and Cross-Section of Machine Shop at Norfolk Downs, Mass.

After the interior piers had been built and before the first floor was laid the site was filled to a height of about 4′ up to the ground floor, with material taken from a nearby hill. The ground floor was laid upon this fill but so reinforced that it is entirely self-supporting, being designed for live weights of 125 lbs. per sq. ft. This floor was centered over two exterior bays in order to form a pipe trench for heating returns, sprinkler piping, etc.

To carry electric wiring, sprinkler piping and for other purposes, inserts are located midway between the lines of columns in each direction, together with one in the center of each rectangle marked off by columns. Besides these, special inserts for specific purposes are located in other positions. The wiring provides for 35 fixed lights, one in the center of each bay, as shown in Fig. 2. The sprinklers are located 8′ 9″ apart in

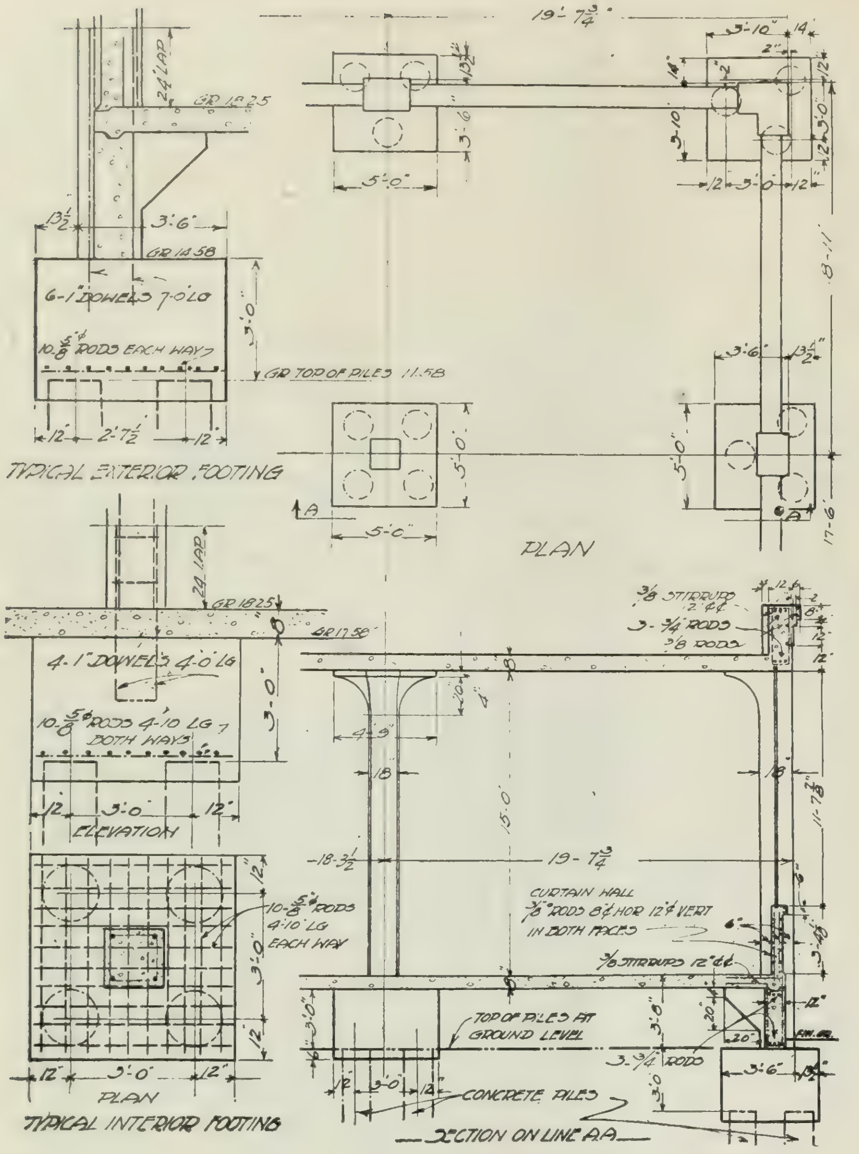

Fig. 4—Sketch Showing Details of Reinforced Concrete Footings, Columns, Slabs and Beams for the Machine Shop at Norfolk Downs, Mass.

one direction by 10′ 8½″ in the other. They are supplied with water from a 6-in. feed line from a pressure tank in the old building and have as secondary supply a 6-in. connection with the city main. There are 131 heads.

CONSTRUCTION NOTES

The aggregate was delivered on the site by wagons and trucks and the sand was teamed from a local pit. A Smith mixer[1] was used with a capacity of four bags per batch, the mix being in all cases 1:2:4, with the exception of the ground floor which was 1:2½:5. A short steel tower was used with a hoisting engine and MacMillan bucket.[2] The forms were all of wood and were carefully laid out in advance of use with the idea of minimizing on the work actually in the building. They consisted of 1½-in. boards for columns and beams and ⅞-in. N. C. pine for the slabs, the latter being all on the loose board system.

The building was designed and erected by the Aberthaw Const. Co., Boston.

Down in Delaware where truck-farming is the principal industry the college at Newark in that State has instituted a test for the purpose of determining the relative merits of concrete and frame buildings for the storage of vegetables. A building has been erected consisting of a concrete basement and two upper stories of frame. So far the experiment has controverted the common statement that concrete is damp and not adapted for the storage of vegetables. Up to date the test has consisted of a record of the moisture prevailing in each department of the building and thus far the instruments show a condition entirely favorable to concrete, thus indicating that it is admirably suited for the purpose described, as well as possessing the further advantage of being more durable and fireproof.

When California starts out to do things, it does them in a big way and when she builds roads, she does not buy her cement on a retail carload basis, but goes into it on a magnificent scale. According to recent advices from San Bernardino in that state, the County Comm. has just decided to start the new country highway system on the road known as Colton Ave., which is to be part of the ocean-to-ocean highway. Just by the way of a beginning, $1,750,000 in bonds have been floated for the enterprise and to the Cal. Portland Cement Co., Colton, a contract for furnishing cement up to 200,000 bbls. has been awarded. Things like this make one believe that there is some value after all in the campaign for Good Roads—which mean concrete roads.

As time rolls by and investigation is made into some of the forts in Belgium which the Germans took after a much shorter period of attack than was expected, discoveries are made as to the conditions of the fortresses themselves. The last report in connection with the forts around Antwerp and also at Namur is that while the plans and positions were of the best and the ordnance used to defend the forts was beyond criticism, the steel and concrete and stone work were of poor quality. At Namur it was found that the concrete supporting one steel turret was so poor in quality that a single German shell demolished it. Allegations of graft are being made in connection with the construction.

The 15th annual summer session of the Coll. of Engrg. of the Univ. of Wis. will be held at Madison during the six wks. period beginning June 21. Special courses will be given in electrical, steam and hydraulic engrg., gas engines, machine design, mechanical drawing, mechanics, shopwork and surveying. All courses given in the university summer session are open to engineering students. Special courses have been arranged for manual arts and vocational teachers. F. E. Turneaure, Madison, Wis., is dean.

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[1] The T. L. Smith Co., 3108-A Hadley St., Milwaukee

FIGS. 1 TO 4—PROGRESS VIEWS OF CONSTRUCTION OF AUSTIN-NICHOLS & CO.'S WAREHOUSES, EAST RIVER WATERFRONT, BROOKLYN, N. Y.

Concrete Plant Used on the Austin-Nichols Building at Brooklyn, N. Y.[1]

BY T. ARTHUR SMITH[2]

The Austin Nichols warehouse, shown in the accompanying illustrations, is situated at Kent Ave. and North Third St., in Brooklyn, N. Y. The structure is 440′ x 178′ 8″ in plan. six stories and basement in height, the story heights being 12′ 6″ from floor to floor. Each typical floor bay is 16′ 6½″ x 19′ 5″ and is carried on 2-ft. x 7-in. beams framing into 2-ft. 5-in. x 12-in. girders, which frame into the columns. The building extends from Kent Ave. along North Third St. to the bulkhead line of the East River, immediately alongside of one of the railway terminals, tracks from which enter the second story of the warehouse. These tracks are carried on steel girders and columns as shown in Fig. 5 but the entire remainder of the building is of reinforced concrete, the structure being of the regular column, girder and slab type.

The contract for the erection of the Austin-Nichols warehouse was awarded Dec. 12, 1913, and called for its entire completion by Sept. 1, 1914. Failure to deliver the building complete by this date would have subjected the contractor to a heavy penalty.

For concreting foundations, a Ran- yd. capacity, was set up west of the center of the building on North Third some mixer,[3] motor-driven, of ½ cu. St.. the level of the street at this point being about 8′ above the general excavation level. The concrete was discharged into a box, from which it was wheeled in concrete carts, of 6 cu. ft. capacity, to the footings. Adjacent to this mixer was placed a vertical boiler of 25-h.p. capacity, the steam from which was used to heat water for the concrete, and to thaw out frozen sand and gravel. Over each footing concreted in freezing weather was placed a collapsible framework, covered with heavy burlap, inside of which was placed a salamander burning coke (see Fig. 1). This method of preventing the concrete from freezing proved entirely satisfactory and made it possible to concrete regardless of temperature. The mixer was used while the excavation, piling, pumping, etc., interfered with the erection of the permanent concrete plants.

Serious difficulties were encountered in excavation and driving of piles, due to the presence of old brick and concrete foundations, cribs, etc.; also, severe cold and heavy snow storms in Feb. materially delayed the progress of excavation and piling, hence holding up the concreting of foundations.

Piling was completed Apr. 7, 1914.
Exacavation Apr. 7, 1914.
Foundations Apr. 11, 1914.

To complete the building entirely by Sept. 1, 1914, required that the roof be finished by July 1, and all concrete work, excepting floors, be completed by July 15. This required the placing of 19,620 cu. yds. prior to July 15.

The general layout of the plans used in the erection of the building is shown in Figs. 5 and 6.

UNLOADING AND CONCRETE EQUIPMENT

The layout of the unloading derrick, storage bins, concrete mixers and hoists is shown in detail in Figs. 7, 8 and 9. Sand and gravel were delivered alongside the bulkhead, adjacent to the storage bins, on scows of about 400 cu. yds. capacity. A derrick equipped with a clam-shell bucket of 1⅝-cu. yds. capacity unloaded these scows into storage bins holding 100 cu. yds. of sand and 200 cu. yds. of gravel. This derrick is shown in Fig. 9.

It was operated by a 35-h.p. three-drum hoisting engine[4] with cylinders 9″ x 10″. For swinging the derrick a separate engine was installed. Power was supplied by a 50-h.p. horizontal boiler.

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[1] Abstracted from a paper presented at the 11th Annual Convention of the Am. Concrete Inst.

[2] Gen. Supt., Turner Const. Co., N. Y. C.

[3] Ransome Concrete Mchy. Co., Dunellen, N. J.

[4] Meade-Morrison Mfg. Co., N. Y. C.

The sand and the gravel were discharged from the bins through Ransome gates,[3] into V-shaped bottom, two-way dump cars for delivery to the mixers. Each car was loaded with 12 cu. ft. of sand and 24 cu. ft. of gravel, a steel partition separating these materials.

One car was used to convey this material to Mixer No. 1, and was pushed by hand from the storage bin to the mixer. For charging Mixer No. 2, a double track of 2-ft. 6-in. gauge was laid from the bin to the mixer, on which two cars were operated, as shown in Fig. 5. These tracks were laid on the first floor, which, in order to follow the grade of North Third St., sloped down 8′ from Kent Ave. to the river. A double drum Lidgerwood hoist,[5] motor-driven, pulled the cars from the bin to the mixer. These cars were connected by a tail-line operating around a sheave at the bin, so that the loaded car going toward the mixer would pull the empty car back to the bin.

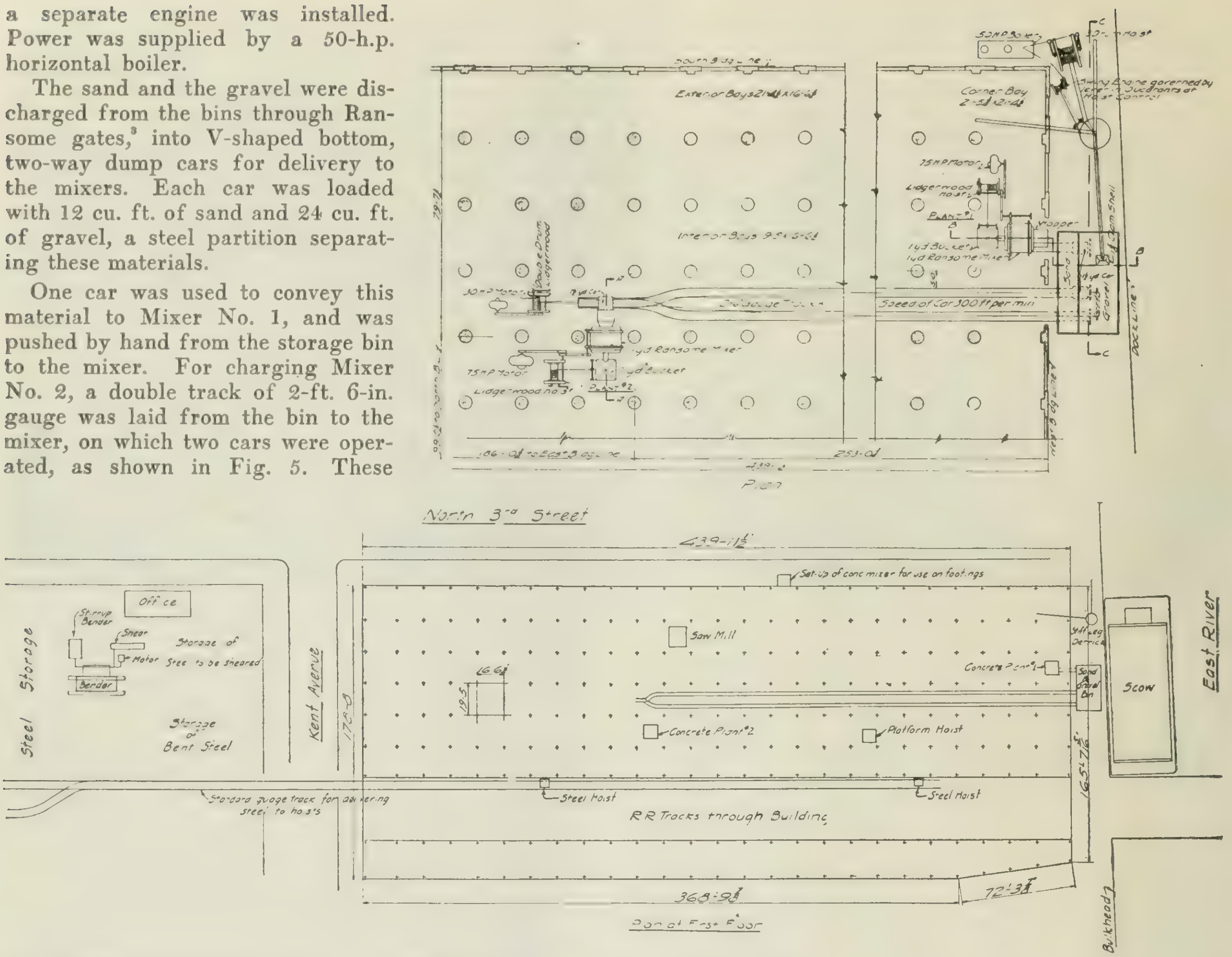

Fig. 5—Sketch Showing Layout of Concreting Plant on Austin-Nichols Bldg.

Owing to limited bulkhead space at the building, it was necessary to dock the cement lighters one block away and truck the cement to the building. Cement was stored adjacent to each mixer. Six bags were used in each batch.

Two Ransome mixers[3] were installed in the locations shown in Fig. 6. Each had a capacity of 1 cu. yd. of concrete per batch. Each mixer discharged into a Ransome[3] bucket 1 cu. yd. capacity, which was hoisted by a single drum Lidgerwood hoist.[5] Power for the operation of each concrete plant was furnished by a 75-h.p. motor. Concrete was dumped from the bucket into a box on each floor holding 2 cu. yds., from which it was wheeled in concrete carts.

The use of spouts for placing concrete was carefully considered. Records of the cost of wheeling concrete on similar buildings showed that this cost did not exceed 9 cts. per cu. yd. This is based on labor at 37½ cts. per hr. doing this work. Assuming that of the 19,620 cu. yds. of concrete to be placed, 16,000 cu. yds. could be placed by spouting, the cost of wheeling saved by this spouting would be 9 cts. x 16,000, or $1,440. Hence $1,440 would have to cover the cost of installing two spouting outfits and the following additional installations incidental to placing concrete in this manner:

Raising tower additional height.
Guying tower.
Moving spouts.

This analysis showed conclusively that, for this building, the cost of the spouting equipments, plus the additional installation cost, would materially exceed the cost of wheeling concrete.

EFFICIENT OPERATION

The successful erection of this building was due to the efficient operation of the equipment. All foundation work was finished Apr. 11 and the roof was completed July 3. Between these dates 17,510 cu. yds. of concrete were placed in 62 working das., an average daily output of 282 cu. yds.

The derrick was capable of unloading 700 cu. yds. of material per da. of 8 hrs. The average capacity of each concrete plant was 45 cu. yds. of concrete per hr. The largest quantity of concrete placed in one da. of 8½ hrs. was 640 cu. yds.

The efficiency of the equipment for conveying materials from the bins to the mixers was demonstrated when, due to a slight breakdown, the derrick was idle for one day. In order to keep one mixing plant in operation, sand and gravel were wheeled from emergency storage piles on North Third St. Charging one mixer in this way required 22 additional men, and reduced the output of the plant to about 30 cu. yds. per hr.

The total labor cost for installing all equipment used in the erection of the building amounted to 20 cts. per cu. yd. of concrete. It must be borne in mind, however, that this cost does not cover any charge for material or use of plant, depreciation or interest on equipment investment.

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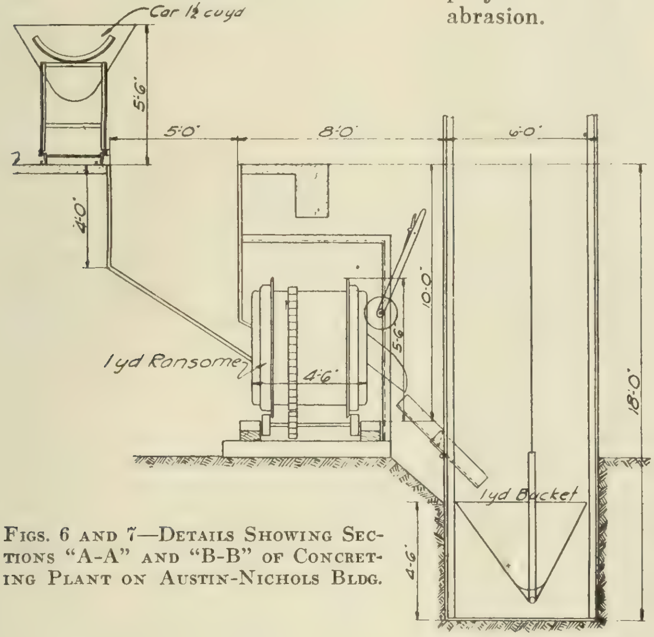
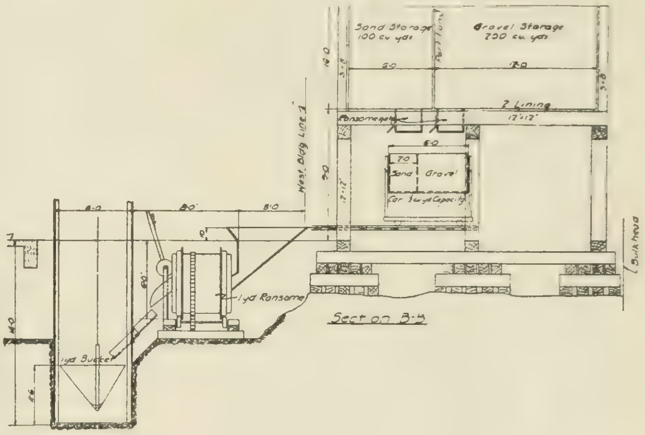
[5] Lidgerwood Mfg. Co., N. Y. C.

PERSONNEL

This building was erected for Havemeyers & Elder, and leased by them to Austin Nichols & Co., wholesale grocers. The Turner Construction Co., 11 Broadway, N. Y. C., executed the general contract under the direction of Cass Gilbert, Archt., in the contract period of 9 mos.





FIGS. 6 AND 7—DETAILS SHOWING SECTIONS "A-A" AND "B-B" OF CONCRETING PLANT ON AUSTIN-NICHOLS BLDG.

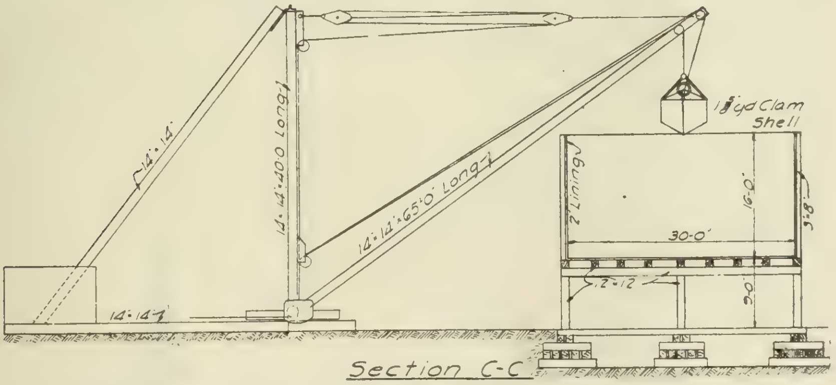


FIG. 8—SECTION "C-C" SHOWING DERRICK EQUIPPED WITH 1⅝-CU. YD. CLAM SHELL BUCKET—CONCRETING PLANT ON AUSTIN-NICHOLS BLDG.

Safety First

In these days of industrial slogans, such as "Safety First," it is gratifying to see that the cement manufacturers have adopted a sound and sensible motto indicative of their product. "Concrete for Permanence" is a strongly descriptive slogan for a material which, properly made, withstands fire and water and improves constantly with age and so far as history goes seems to endure forever. It is well that the industry has adopted such a motto and it is well that it is to be used by the various manufacturers on letter paper, advertisements, etc., for the purpose of driving home the message that should be in the mind of all who have construction work to do or to be done.

Broomed surfaces for concrete roads are not so common now as they were. Brooming merely weakens the surface and presents a series of projections which greatly increase abrasion.

Concrete As a "Silencer"

The Maxim Silencer to deaden the noises from firearms has caused all sorts of discussion and fun. Now comes concrete as a competitor of the Maxim silencer in the suppression of noise caused by railroad trains over viaducts. A recent report of the gen. pass. agt. of N. Y., Westchester & Boston Ry., states: "The multiple unit coaches operated by this company weigh about 65 tons each, yet the passage of a train over a viaduct having a concrete bed is practically noiseless." Thus concrete finds another use and the nerve-wracking noises that have hitherto disturbed the composure of the commuter will give way to peaceful gliding over smooth tracks and deadened viaducts while the passenger sweeps on his way to his happy home.

While N. Y. C. shows an increase in building permits over last year and to the uninitiated eye it would seem that a great demand for cement was therefore imminent in that locality, it must not be forgotten that N. Y. C. is threatened with a new building law which will cut down the height of buildings. This fact has a great deal to do with the present rush for building permits. Another fact which even after permits are granted is restraining the construction of many new projected edifices and which also must be reckoned with is the high rate for building loans. The man who pays the ruling rate of 5½% or 6% for money and erects an apartment house or an office building must recollect that his office or his apartment will compete in rentals with other similar constructions financed last year and the year before on 4% money.

The order of turning in the hand mixing of concrete should be so regulated that the last turn made will place the material in a single pile, at or near the center of the board, preparatory to its removal to the place for it in the work.

The quantity of cement should invariably be regulated by its weight; if the proportions are stated by volume, a definite weight or number of packages of cement must be assumed to the unit volume.

New Equipment, Methods and Materials:
New Tools with Which the Industry Works

This magazine will not publish "reading notices," so-called, for the benefit of advertisers. These pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers are constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.—THE EDITORS.

A Unique Nail-Collar for Form Nails

The accompanying illustration shows the Pull-Easy nail collar[1] which is used in combination with common wire nails in constructing concrete forms, falsework, scaffolding and in other places where wire nails are used for temporary purposes. They effect considerable saving in time and lumber for such work. They also save the concrete work from jars and jolts in taking down forms, thus allowing the concrete surfaces to be "rubbed up" and certain faults corrected earlier than would be advisable otherwise.

PULL-EASY NAIL-COLLAR

It has been found that the use of the collars greatly increases the life of lumber for formwork, allowing the lumber to be used in some instances as many as 12 times before entirely used up. The item of cleaning lumber has also been cut approximately in two. With the nail collar it is an easy matter to take down separately each plank in beam and column forms, for example, from the side of a deep beam instead of dropping the entire side and probably shattering one or more planks.

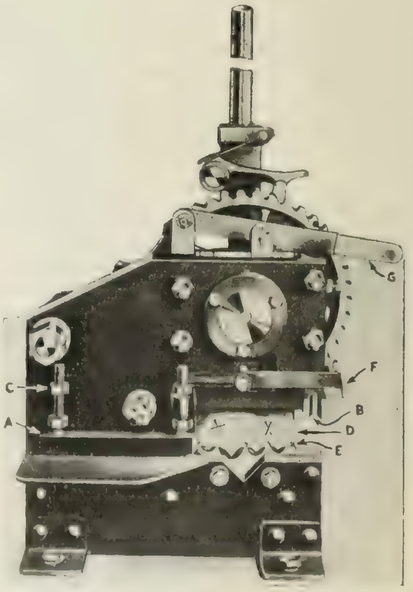
The nail collars are made from steel in three sizes to fit all sizes of nails. The large flange on the collar increases the drawing power of the nail. The collar leaves the head of the nail projecting far enough out of the wood so that the claw of a hammer or nail-puller can easily catch it.

Hand-Power Open-Throat Shears for Cutting Heavy Reinforcing Bars

The accompanying ilustration shows one of several styles and sizes of Wallace shears[1] for cutting reinforcing bars. This apparatus, known as No. 3 open throat shears, is suitable for cutting square, twisted or deformed bars up to $1\frac{1}{4}''$ in size or flat bars up to $3'' \times \frac{5}{8}''$.

The frame consists of a solid steel plate of substantial construction. The shears have an open throat and the bars can be rapidly placed into position for cutting. The tool is so geared as to develop an enormous power so that the shearing of heavy bars is easily accomplished by hand. The length of the blades is $7\frac{1}{8}''$ and the net weight of the machine is 440 lbs.

In operating the apparatus, the stripper *A* swings horizontally so that the bolt fits into groove *B* where it is secured to place by turning down nut *C*. *D* and *E* are the hardened steel shearing blades. By pulling lever *F* blade *D* can be raised by means of lever *G*, when the cut has been finished, thus effecting quick release of the bar which was cut off. The leverage is compounded for cutting heavy bars, but the machine can be quickly converted to direct leverage for cutting bars of small diameter.



"WALLACE" NO. 3 OPEN-THROAT SHEARS

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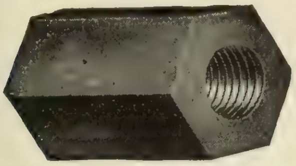
[1] Wagner-Behm Co., 20 East Jackson Blvd., Chicago

[1] Wallace Supplies Mfg. Co., 414 Orleans St., St., Chicago

A Malleable Coupling for Reinforcing Bars

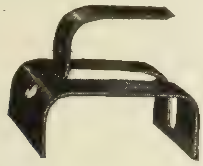
The Marion malleable iron coupling[1] shown in the accompanying illustration is made in a complete line of sizes for column bars and other places in which butt connections of reinforcement are desired.



Marion Malleable Coupling for Reinforcing Bars

The U Bar Support

A U bar support[2] for holding reinforcing bars in girders, walls and hollow tile floor joints, is shown in the accompanying illustration. The device is very simple in construction, being stamped in one piece from heavy gauge steel, and is easy to apply. One size fits all sizes of bars up to 1″. The support does not obstruct the flow of the concrete and when used for wall reinforcement, it is fastened to the forms with a small nail.

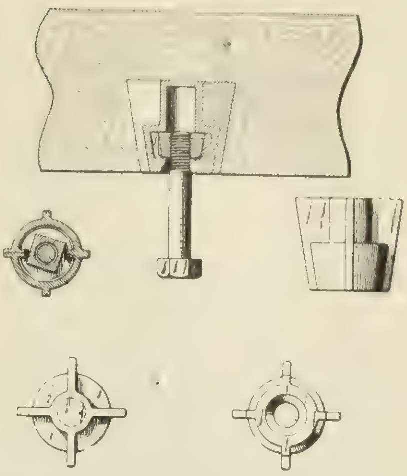


U Bar Support

A Novel Concrete Anchor

A novel concrete anchor[3] for fastening hangers, beams and machinery to concrete ceilings, floors and walls is shown in the accompanying illustration.

The principle involved in the new anchors is the peripheral wedge action of the anchor member against the concrete in which it is embedded. The portion of the anchor having the smallest tranverse area is adjacent to the outer portion of the concrete mass in which it is embedded, while the expanded portion of the anchor casting is extended into the concrete mass. Exterior longitudinal ribs provided on the anchor increase its strength and effectiveness as an anchor device. The anchor casting is hollow and has a screw nut arranged in its lower chambered portion, of such size as to prevent its removal from the chamber. The ribs also prevent its turning under tension.



Sketch Showing Details of the Smith Concrete Anchor

An interesting test made with this type of anchor disclosed that its area of pressure on surrounding concrete extended over a considerable area, due to the side pressure exerted in consequence of its wedge-like operation. In the particular test mentioned it was ascertained that a $2\frac{1}{8}$-in. anchor of this type exerted pressure over a surrounding area of 320.47 ins., whereas a mere $2\frac{1}{8}$-in. disk anchor would have an area of pressure merely of 9.18 sq. ins.

The nut contained within the anchor chamber is prevented from turning by guiding instruments that contact with it. It is, however, free to oscillate and the bolt can be inserted at a considerable angle and find the nut, in this manner allowing for discrepancies in the setting of the anchor. As the anchor chamber is closed at the top there is no danger of water from wet concrete getting in and rusting the nut.

The anchor may be either of an inverted frusto-conical shape, with ribs added, or of inverted rectangular pyramidal shape. But in either case the frustrum has the same wedge-like operation on surrounding concrete. The anchor may be attached to the forms by nails and thus held in position while the concrete is being poured around it.

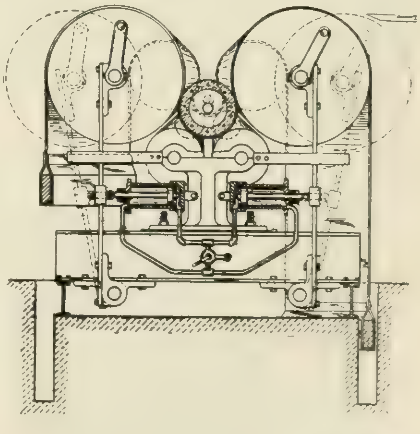
Delphos Metal Shingles, The Roof Permanent—The Delphos Mfg. Co., Delphos, Ohio, paper, 10″ x 7″, 16 pp., illust. This booklet illustrates and describes the Delphos raised side-locking joint used in connection with the Delphos metal shingles. The method of laying these shingles is also given, and a description of other products made by the same company.

Manufacturing Reinforced Concrete Poles or Piles by Rolling

A concrete pole hollow or solid, straight or tapered, reinforced as desired, in all lengths up to 35′ is made by rolling by the Jones machine[1] shown in the accompanying illustration.

The compression rolls are made on the same ratio of taper that the manufactured article will be. When pipe is made, straight rolls are used. A very heavy canvas belt is placed on the top compression rolls, and the reinforcement and the inner core are laid on this and between the rolls. Each end of the belt is weighted down with an iron bar along its entire width. These widths operate as a counterbalance and maintain a tightening effect throughout.

The compression rolls are opened by the cylinders shown, the top rolls are turned inwardly by the driving equipment shown, the counterbalance weights rise and the reinforcement and the inner core are lowered to contact with the idler rolls below. The air or the steam is then reversed, imposing a compression upon the collars at each end of the reinforcements and core, the concrete is fed in from the top by means of a measuring and distributing box and one compression roll is then driven very slowly, not exceeding 10′ travel per min. The product is turned with the concrete aplied, approximately $2\frac{1}{2}$ revolutions in one direction, the driving power connecting this roll is then disengaged by clutch and the other compression roll is driven in the opposite direction. This reverse opera-



Rolls for Manufacturing Reinforced Concrete Poles and Piles—Jones System

The sketch shows the principle of the compression rolls and the belt type machine for forming poles, piles and pipes of plastic material tion continues until the product being formed is in shape and thoroughly compressed.

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[1] Marion Malleable Iron Wks., Marion, Ind.

[2] Universal Stamping Co., Ltd., Strasburg, Pa.

[3] Invented by Harry J. Smith, Lakewood, Ohio, and patent rights acquired by the Hill Clutch Co., Cleveland

[1] R. M. Jones, 1144 Humboldt St., Denver, Colo.

The vertical steel standards composing the frame, in combination with the pressure applied by the air or steam cylinders and the tension constantly retained by the weights upon the belt, cause a more thorough compression effect than that of the hydraulic press, because the aggregates composing the concrete mass receive their compression from different directions in succession, and the compression is maintained by the belt.

It is found in practice that this peculiar rolling compression will expel all water that is not actually needed in filling the voids. More water is unnecessary until the curing period is reached; the concrete should then be treated with ample water.

The pole, pile or pipe becomes a hard and true surface within 5 min. from the time the concrete is applied, but in order to retain the moisture in the product during its original setting period, there is provided a sheet of canvas wide enough to encircle the product two turns and a lap, coated with a mineral rubber paint, and fed between the belt and the outer surface of the product by placing its edge between them and revolving the article two turns. Brads with small heads are then driven through the three thicknesses of canvas and into the concrete, and the product is discharged from the forming machine in the following manner: The pressure is reversed, thus parting the top compression rolls. These top rolls are then turned in their opposite directions and the counterbalance weights on the belt bring the finished product to the top of the rolls whence it is rolled away to a distant point on the circular curing table. After 24 hrs. have elapsed, the canvas cover is removed and the product is kept wet until thoroughly cured.

This rolling process in compression causes better tamping effect than can be accomplished in any other manner. The concrete mix is quite dry, but the compression is sufficient to cause water to run from the surface.

The core is composed of sheet metal, made collapsible and remains in the pole until the concrete becomes set. The core is then removed; the pole rests in an undisturbed position for 5 das. or 6 das., on the curing table with ample water given to it.

The ratio of taper adopted is 1″ in diam. for each 6′ in length, as applied to poles 6″ top diam. The minimum thickness of the concrete wall is 1½″. Two inches is preferable.

Poles 35′ in length should be 12″ in diam. at the butt, and 6″ at the top, or 14″ butt, and 7″ top, or 16″ butt and 8″ top.

The ratio of belt travel on the compression-rolls machine is 2:1, therefore the butt of a 36-ft. pole will be twice the diameter of the top.

The ratio of taper of the compression-rolls may be made as ordered for each manufacturing plant, but the schedule described above is properly proportioned.

The reinforcement is centrally located in the concrete wall and composed of ¼-in., 5/16-in., ⅜-in., 7/16-in. or ½-in. square twisted steel reinforcing bars, woven with steel wire warp at desired intervals. The five sizes named will accomplish the desired differences in strengths for application to various services. Reinforcement consists of 10 bars of any selected size the entire length, 18 bars ⅔ of the length, and 26 bars ⅓ the length of the poles.

Poles for special service, such as span work or guys, will receive largest reinforcement in the greatest tension side.

The reinforcement is woven on a tapered mandrel in a specially prepared loom shown on page 17, which, after being woven and taken from the mandrel, is placed upon the forming core and the warp which forms the circumference reinforcements is united by twisting one around the other. The warp may vary in size from No. 6 to No. 10 steel wire spaced at intervals as required for producing the desired strengths.

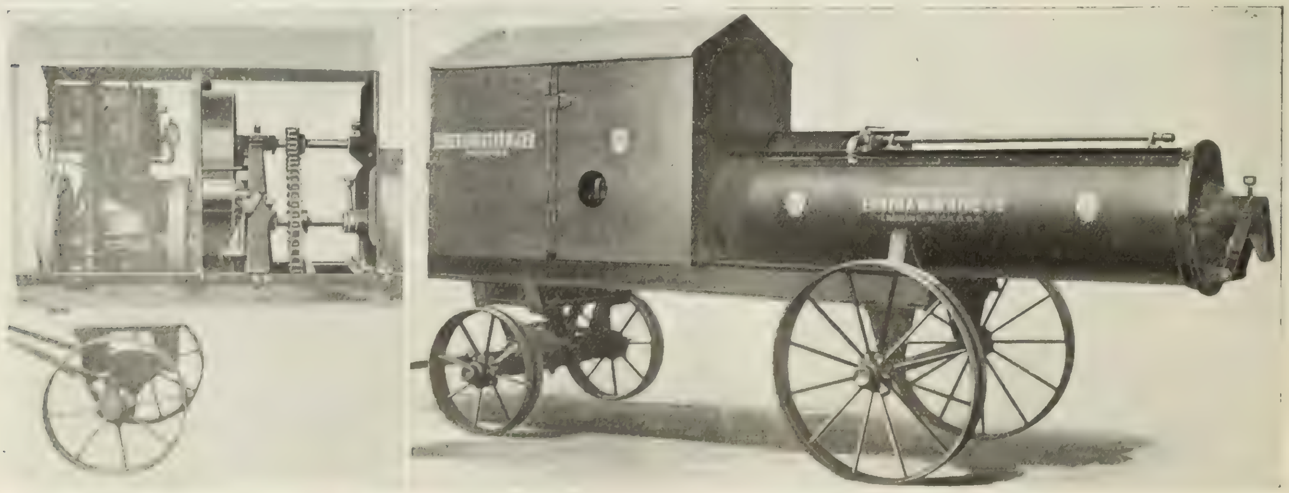
The woven reinforcement is held centrally between the inner core and the outer circle, by pole-step sockets woven between two bars of the reinforcement. A scheme is also provided for centralizing the reinforcements at other points around the pole.

These poles may be formed just as desired, and the reinforcements may be heavy or light and spaced as desired. The labor and the concrete cost are the same for all strengths, therefore the steel used is the only element that governs the difference in strength and cost.

A Machine Mortar and Plaster Mixer

The accompanying illustration shows the Eureka mortar and plaster mixer,[1] which can be used for mixing concrete in small quantities. The mixing is done by a rotating shaft set with detachable blades and operating in a cylindrical steel drum open at the top and having over one end a hopper into which the materials are shoveled.

The drum is 18″ in diameter and 16′ long with its end closed by a special discharge door. The shoveling height of the hopper top at the front end of the drum is about 45″.



THE EUREKA MORTAR AND PLASTER MIXER

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[1] Eureka Mach. Co., 100 Handy St., Lansing, Mich.

The New-Way engine[2] is 4½ h.p. gasoline with belt drive to the paddle shaft. A substantial steel housing protects the engine and gearing from the dirt and weather. One door in front and two doors on either side allow quick access. The total weight of the mixer is 2,450 lbs.

It is claimed that one man operating the mixer will produce as much mortar as three men working by hand and that each bricklayer will lay from 300 to 400 more brick per da., when furnished with machine-mixed mortar.

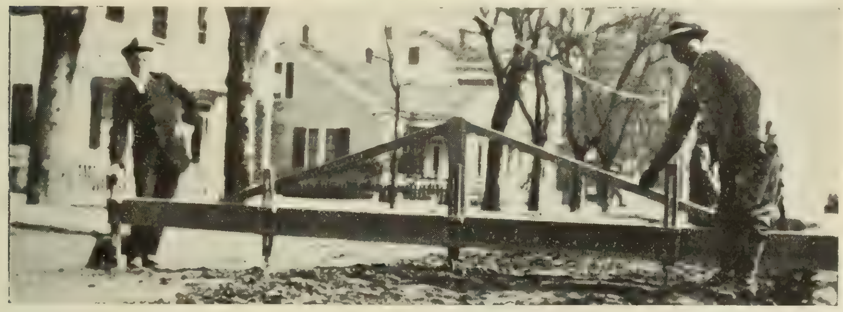


Fig. 1—Adjustable Crown Template for Grading Streets

An Adjustable Crown Template for Grading Streets

An adjustable crown template has been invented by T. Keith Legaré, Columbus, S. C., to be used for setting stakes to serve as guides in forming the crown of roadways, thus doing away with a large part of the work of the engineer, since the template when once set for a given crown and width, can be used by any intelligent foreman for this purpose.

The novel features of the invention will be apparent from the following description taken in connection with Figs. 1 and 2:

Referring to Fig. 2 the template will be seen to consist of a horizontal beam made of wood or any suitable metal, with several gauges mounted thereon, which slide vertically and can be fastened at any position. The number of gauges which the inventor prefers is five. The gauges are preferably spaced at equal distances apart. Each gauge is provided with a slot extending nearly its entire length, and through each slot and the beam passes a bolt with a washer, by which the gauge is fastened at the desired position. Each gauge carries along one edge a scale divided into inches and fractions thereof, and is held in a vertical position by passing through guides attached to one side of the beam.

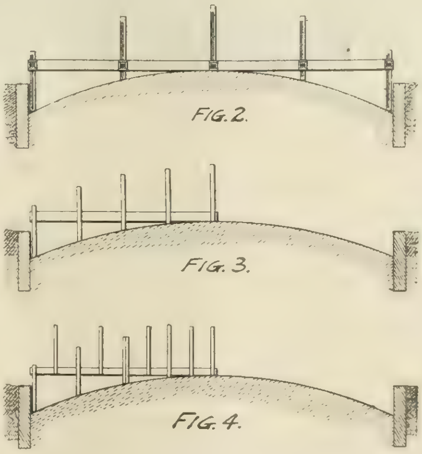
In order to secure accuracy the template may be provided with suitable spirit levels at the ends of the gauges, thus obviating the necessity for a surveyor to set each stake by means of a surveying instrument.

The arrangement shown in Fig. 3, where the template extends from the beam, so as to be set in a perfectly level position.

Fig. 2 shows the template extending from one curb to the other and in order to determine the heights of the roadway at points between the curb and the center the intermediate gauges may be set so that the lower edge of the beam registers with the proper mark on the scale. When the gauges have been set to their proper position the template may be moved from one position to another along the roadway and stakes driven to correspond with the lower ends of the curb to the center or crown of the road, is designed for use on roads which are much wider than that shown in Fig. 2. In this case the gauge at the curb of the road is set to show the proper elevation of the crown above the level at the curb and the intermediate gauges are set to indicate the proper curvature. By this arrangement it is possible accurately to determine the surface of the roadway as the beam may be leveled by means of spirit levels.

In the arrangement shown in Fig. 4, designed for use on a very wide road, two templates may be used and stakes set for one side of the road at a time or four templates could be used to span the whole width of the road. One end of one of the templates in this arangement is set at the curb and the other end at a point ¼ of the distance across the road. The second template is arranged at the end of the first and extends to the center of the road. Or, if desired, one template can be used in this arrangement for the entire operation by first setting the stake for ¼ of the roadway and then simply changing the position of the gauges and moving the template over to the next quarter. Thus only one template is necessary to secure all points on any height of crown of any width of roadway.

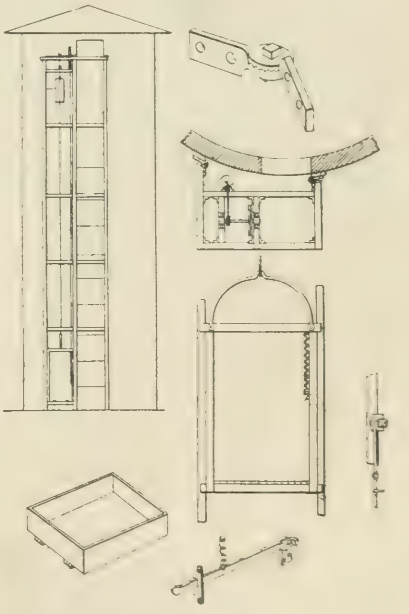
In order to render the use of the template more convenient tables may be prepared showing the various positions to which the gauges should be set in order to give different degrees of crowning to the road and with such tables it is possible to set the template quickly and locate the stakes for a long section of roadway.



Figs. 2, 3 and 4—Sketch Showing the Manner of Using the Legare Template for Grading

A New Silo Elevator

The accompanying ilustration shows a device for removing ensilage from silos.[1] Its construction is self-explanatory, consisting of an elevator, a frame, a carrier mounted to slide therein and hingedly connected members, one of which is secured to the frame, the other of which is movable, to permit connection with



The Lawless Silo Elevator

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[2] The "New-Way" Motor Co., Lansing, Mich.

[1] Invented by C. J. Lawless, Lincoln, Neb.

supporting structures of different radii.

The counterpoising member is of sufficient weight so that when the receptacle is empty, the member will effect an elevation of the carrier, together with the operator, the weight of member being just sufficient to overcome the weight of the carrier and the weight of the operator. When the operator has been elevated to the height of the ensilage in the silo, a lever is released, whereupon a jaw will engage one of the guides, and hold the carrier in position. The operator then enters the silo, and pitches out the desired quantity of ensilage, a small portion of ensilage being thrown into the receptacle. The ensilage which is deposited in the receptacle will, when the operator stands upon the carrier, be sufficient to cause the carrier to move downward, slowly, the downward movement being controlled by means of the brake mechanism, as shown.

A New Type of Concrete Wall Construction

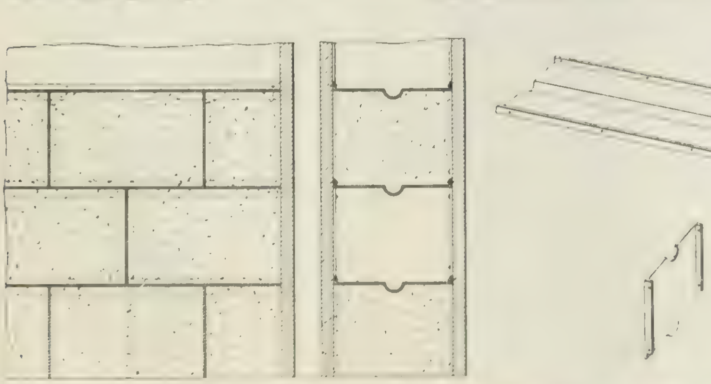
In the type of concrete wall construction[1] shown in the accompanying illustration separate and distinct blocks are molded in situ in successive layers, to break joints as in walls built of previously formed blocks. In connection with the blocks, metallic joint members, preferably of sheet metal, are employed and molded in place in the molding of the successive layers of the blocks, there being horizontal and vertical joint members co-extensive with the adjacent surfaces of the blocks at the joint. The joint members form part of the mold and are so shaped as to cause interlocking of adjacent blocks.

In producing a wall in accordance with this invention a mold is formed to permit pouring and molding the material to form the bottom or the first layer of blocks. The outer members of the mold consist of sides formed, in practice, of planks or the like. Before pouring the concrete for forming the block, vertical joint members are so disposed as to separate the block and to form transverse members of the mold, the vertical joint members having lateral flanges which are nailed to the inner faces of the sides of the mold. The concrete having been poured, horizontal joint members are laid on the block and are fastened to the inner faces of the sides of the mold through the medium of vertical flanges on the said joint members, suitable nails being driven through the flanges into the sides. The horizontal joint members are formed with longitudinal concavo-convex ribs to form grooves in the block at the under side of the members. These ribs will also form longitudinal tongues on the under side of the next layer of block. The vertical joint members are formed, on the top and the bottom edges respectively, with depressions and lugs corresponding with the ribs so that the horizontal joint members may take a firm seat on the vertical members.

The first layer of block having been thus completed with their horizontal and vertical joint members, the next upper series of vertical members is secured to the inner faces of the sides of the mold through the medium of the lateral flanges, the vertical joint members being disposed intermediate to the lower series of vertical joint members so that the second layer of block will break joints with those below. The concrete for the second series of block is now poured and at the proper time the next horizontal joint members are on top of the block and fastened to the sides of the mold.

The forming of successive block will thus produce longitudinal tongues on block of one layer and corresponding and aligned grooves in the opposite faces of the block. Thus the joint members and the block will be interlocked with one another and the block will be separately formed.

The wall now having been completed to the proper height, the sides of the mold are removed and preferably the flanges of the joint members are stripped or cut off, leaving the joint members co-extensive with the adjacent faces of adjacent block. A plaster coat is laid on the faces of the wall and the joints may have the usual markings after the manner of brickwork or other block work.



SKETCH SHOWING THE CAHILL SYSTEM OF CONCRETE WALL CONSTRUCTION

A New Wire Straightener

The device shown in the accompanying illustration, known as the Economy wire straightener,[1] may be used for straightening wire from the coil for fence post reinforcing. It is also adapted for shaping wire into reinforcing spirals of any desired diameter for concrete columns and silos, or in making up stirrups for beam reinforcement. The No. 1 machine will straighten wire up to ¼″ in size, while the No. 2 machine will handle wire from ¼″ to $^7/_{16}$″ in size.

THE ECONOMY WIRE STRAIGHTENER

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[1] Invented by Thos. J. Cahill, 20 Seabright Ave., Santa Cruz, Cal.

[1] John P. Haga, 1021 East 28th St., Minneapolis

A New System of Adjustable Concrete Floor Forms

The vertical shores supporting the joists and lagging for floor slab and beam centers usually require considerable cutting to fit and finally minor adjustment with wedges. An adjustable shore which has been designed to eliminate both of these tasks is shown in the accompanying illustrations. This shore consists of two 2-in. x 4-in. timbers with cap and cleats, as shown in Figs. 1 and 2, between which telescopes a 4-in. x 4-in. timber. Two tightening clamps hold the telescoping posts rigid when they have been adjusted to the length of shore desired. For final adjustment of length the shore jack is used as shown in Fig. 1.

ADJUSTABLE MAT LAGGING

Sheet metal is being used more and more in connection with form work for reinforced concrete buildings, and a new adaptation of this material in connection with a mat lagging is shown in Figs. 2, 3 and 4. These mats,[1] consisting of a set of parallel bars connected by chain, are of such size that when rolled up one man can carry and adjust one. In making up the mats the slats are placed a distance apart greater than the size of the slat to allow for adjustment of the slats of the adjacent mat. They are laid on the centering joists and covered by a lagging of steel plates.

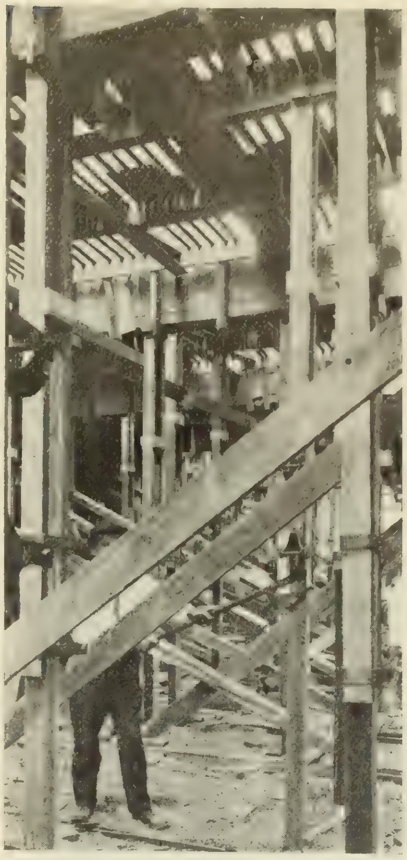


Fig. 1—Adjustable Shores for Floor Forms

These mats are adjustable both horizontally and longitudinally without in any way altering the size of the centering joists or mats. The horizontal adjustment is effected by lapping the mats. The lap can be made 1′ without interfering with the chain in any way. If a further adjustment is desired, one mat can be placed with the chain down and the next one with the chain up. Adjustment lengthwise with the mats is obtained by simply putting enough mats together to form the required length. Some play can also be obtained by pushing the individual pieces in each mat closer together, there being ½″ leeway in every 4½″.

This system has been used on all kinds of reinforced concrete floor work, both flat slab and beam and girder. When using it in beam and girder construction, a stringer is placed parallel to the beams and half-way between them. A ledger is also placed on the edge of the beams and the mats rest on the ledger and the central stringer. As these mats are about 4′ long, an adjustment of from 4′ up to 8′ can be obtained with two mats and a larger adjustment can be obtained by using three mats with two intermediate stringers. As the mats are adjustable and as stringers do not have to be cut, considerable saving in lumber is accomplished by using this method.

APPLICATION OF SYSTEM

Fig. 3 shows this system in the Good Samaritan Hospital in Cincinnati after the slab has been concreted and a portion of the form work removed. Its use in this particular job is described by W. P. Anderson[2] in the *Engineering Record* from which the following has been abstracted:

> The ceilings in this building had to be plastered and a very light-gauge metal lath was used on top of the mats instead of metal sheets. Two different kinds of lath were used, but the most satisfactory was a 26-ga. spiral lath manufactured by the American Rolling Mills Co. This lath cost 11 cts. per yd. in this case, and could probably be bought cheaper if purchased in larger quantities. The lath remained on the ceiling, was not wrecked, and gave an ideal surface for plastering. In concreting on this lath it was not necessary

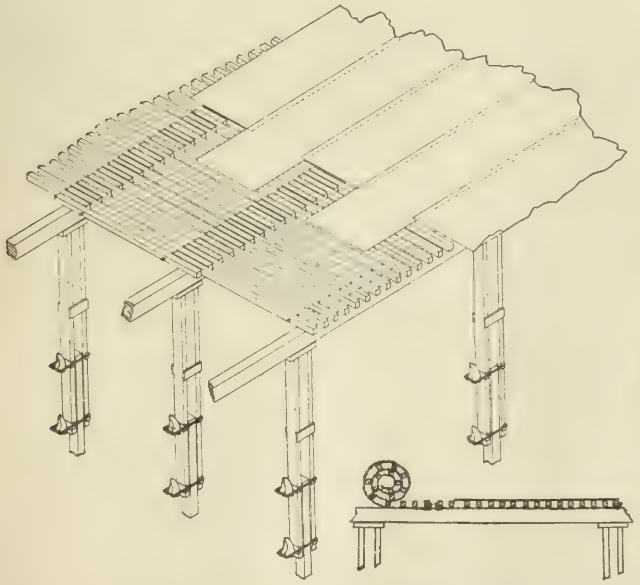
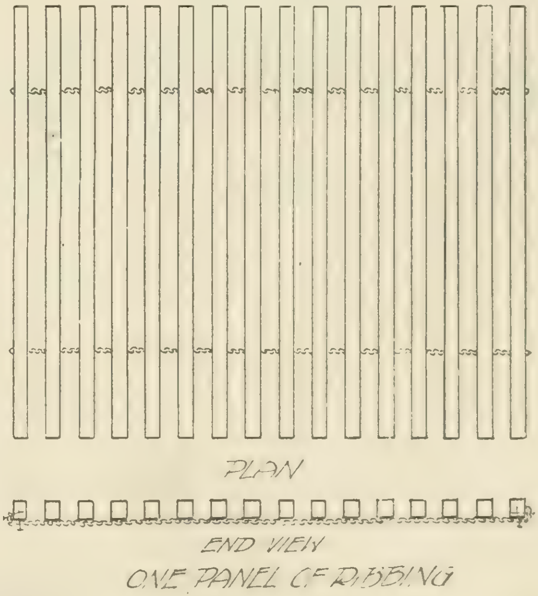


Fig. 2—Sketch Showing Adjustable Shores and Mat Lagging for Floor Forms



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[1] Invented by Jesse E. Hodges, and made by Edward O. Keator & Co., 2851 Melrose Ave., Cincinnati, Ohio

[2] Pres., Ferro-Concrete Constr. Co., Cincinnati

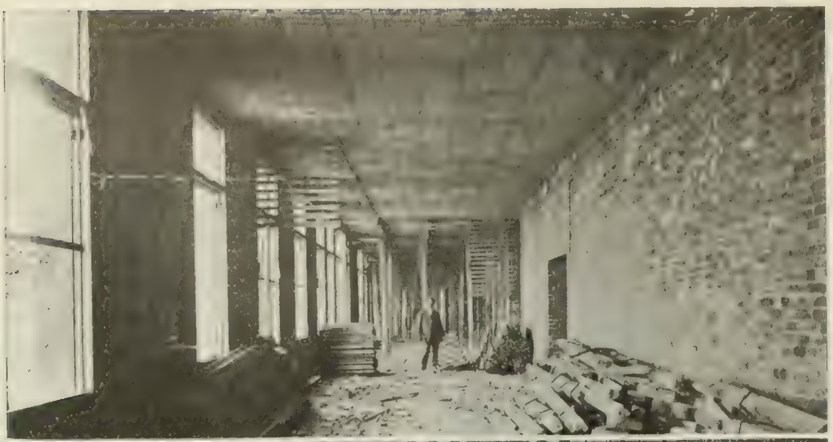

FIG. 3—FORM MATS USED IN CONSTRUCTING THE GOOD SAMARITAN HOSPITAL, CINCINNATI

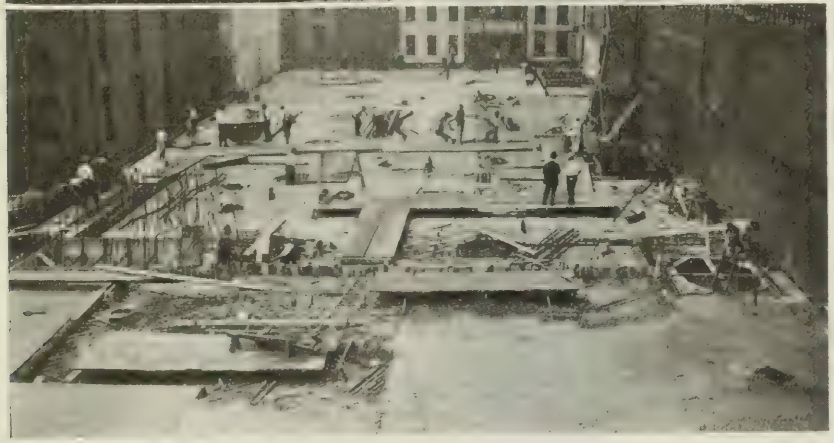

FIG. 4—SHEET METAL NAILED TO FORM MATS IN CONSTRUCTING THE LIPPINCOTT BLDG., CINCINNATI

A portion of the mat can be seen hanging from the ceiling in Fig. 3, while the mat can be seen in the background in Fig. 4 with the sheet metal nailed to it, and in the foreground concreting is going on.

to use a drier concrete than is advisable for good work, and the concrete was such that it would flow through such a chute as is ordinarily used to distribute concrete from a hoist bucket in building work. In placing the lath the edges were lapped a few inches, but it was found better to keep this lap as small as possible or avoid any lap where the ends rested on a solid part of the mat. By doing this, less lath was used and it was bound more firmly to the concrete. In Fig. 3 can be seen a portion of the mat hanging from the ceiling. In the building this kind of form was used in one part and regular wood forms were employed in another part, and the superintendent in charge found that the special forms were erected more rapidly than the others, which, of course, could not be used over and over.

Fig. 4 shows the Lippincott Bldg. in Cincinnati, in which this system of forms was also used. In this case the ceilings were not to be plastered and 26-ga. galvanized sheets were used, being laid with laps in a line across the building so that the ceiling had a paneled effect after it was finished. This building had seven floors and a roof. Sheet metal was used for two floors, the metal being used more than four times, and at the end of the job it was still in condition for further use. A hand roll consisting of two iron rollers straightened out the sheets that became buckled. It was easy to place the electrical conduits and inserts on this floor and to nail the metal to the matting, and these holes did not damage the metal to any great extent.

Trade Publications □

Staple Concrete Post Molds—Staple Post Mold Co., Westerville, Ohio, 10½" x 7", paper, illust., 48 pp. This catalog is quite unusual and interesting, particularly in view of numerous illustrations which show various operations in manufacturing the posts in actual commercial plants. It shows factory arrangement and equipment under working conditions and contains a great deal of information.

Eureka Concrete & Mortar Mixers—Eureka Mach. Co., Lansing, Mich., paper, 6¾" x 9¾", 32 pp., illust. This exceptionally well arranged catalog takes up in minute detail the mechanical features of the Eureka mixers. Complete specifications are given, and photographic views of actual installations are numerous.

Dundee Falls and Falls Village Developments—Stone & Webster Engrg., Corporation, Boston, paper, 10¼" x 7", 20 pp., illust. This publication describes in an interesting manner the Dundee Falls and Falls Village Developments of S. D. Warren & Co., and the Connecticut Power Co., respectively. The former development is about 15 mi. northwest of Portland, Me., on the Presumpscott River, while the latter is on the Housantonic River at Great Falls, Conn., ½ mi. above Falls Village.

The Knickerbocker Line of Concrete Mixers, 1915—The Knickerbocker Co., Jackson, Mich., paper, 9" x 6", 40 pp., illust. This well illustrated catalog considers in detail the new Knickerbocker batch mixer, and the well-known Coltrin continuous mixer. Complete specifications are given for both types of mixers. The illustrations are well selected.

Radiation Pyrometers, Type "B," Bulletin No. VI—Thwing Instrument Co., Philadelphia, paper, 10" x 6½", 16 pp., illust. This bulletin illustrates plainly how the reduction pyrometers are used and some of their practical applications to cement kilns, hardening steel, etc. A list of a few users of these pyrometers is also given.

The Calculagraph in Your Business, Accurate Cost Records—Calculagraph Co., N. Y. C., paper 9¼" x 6¼", 32 pp., illust. This well illustrated catalog considers the Calculagraph in a manufacturing business, and shows how elapsed time is recorded, being accompanied by actual Calculagraph records.

Through the Meshes, Jan., 1915, Vol. 7, No. 7—The W. S. Tyler Co., Cleveland, paper, 6" x 4½", 24 pp., illust. This monthly house organ is issued for circulation to all within the business range of the company. It takes up in considerable detail the selling end, and contains some interesting facts.

The Wendell Centrifugal Coal Drier, Bulletin No. 212—Link-Belt Co., Chicago, paper, 6" x 9", 4 pp., illust. This folder describes in detail the construction of the Wendell continuous automatic drier, which is a compact, self-contained machine in which the drying of coal by centrifugal force has been converted into an automatic and continuous operation. Although primarily designed for drying coal, the machine has a wide range of usefulness and may be employed for removing mechanical moisture from many materials.

Chabelco Steel Chain Belt, Catalog No. 54—Chain Belt Co., Milwaukee, paper, 10" x 6¾", 32 pp., illust. This catalog describes in detail the manufacture of Chabelco Chain Belt, which is particularly adapted for lime, stone, cement, sand and gravel plants. It is made in some 75 styles and sizes and is used for transmission, elevating and conveying purposes. The pins and the bushings are case-hardened and then tested for hardness by the scleroscope, which is the standard instrument used for this purpose. The last few pages of the catalog show for what purposes these chain belts can be used.

The Blaw System, Bulletin 65—Blaw Steel Construction Co., Pittsburgh, paper, 9" x 6", 16 pp., illust. This bulletin describes in detail the construction of Blaw steel sidewalk, curb, and curb and gutter forms. Typical installations of these forms are illustrated by photographic views, as well as the method to be employed in constructing sidewalks, curbs and gutters. The Blaw steel forms for concrete road construction are also well illustrated.

Concrete-
Cement Age

Vol. 6 *Detroit, June, 1915* *No. 6*

Capitalizing Your Failures

IT is made very clear in the article on p. 278 by Charles E. Sims, a member of the Board of Associate Editors of this magazine, how success is achieved through failure. Mr. Sims knows concrete drain tile manufacture as few men know it. He describes, for the benefit of others, a failure of his own product under adverse conditions. It is a notable mark of generosity to do a thing like this, particularly when the author went to the trouble of finding out all the *whys* of the failure. The facts of the conditions and causes of this failure of concrete drain tile are particularly valuable. They are much more convincing than theories, yet probably Mr. Sims's greatest service in the article referred to is in making it quite clear how all concrete workers—whether making drain tile or block or erecting bridges or buildings—can really capitalize their mistakes by minutely analyzing them.

The Life of Stucco

SINCE the May issue a reader asks for information as to the expected life of exterior walls of stucco on metal fabric. So far there are on hand an even dozen interesting discussions which will, undoubtedly, be published in July. The inquiry is not of a nature easily answered, because so much depends upon the metal fabric and even more, probably, upon the stucco—its density, thickness and method of application, and upon the character of the construction which supports the metal fabric. Yet with all the "ifs" which enter into the discussions so far contributed, the inquirer will come near to getting what he wants if testimony is given by a great many who have had experience. It is, therefore, especially urged that everyone who has definite knowledge of the lasting qualities of stucco on metal fabric for exterior surfaces report what he knows. Hundreds of readers have some knowledge of the subject which should be of value in arriving at an idea of this type of construction under all conditions. Please state all the conditions known to you in connection with the particular instance of failure or success which you cite. This is a subject distinctly worthy of thorough investigation.

The 28-Da. Test

ONE of the common cases that come up in the use of concrete under specifications has recently occurred at Los Angeles, Cal. Specifications for testing cement for use in the improvement of the Broadway Tunnel require results at 28 das. Owing to a shortage the contractor asked that he be permitted to have the cement accepted on a 7-da. test, he assuming the responsibility for all the materials. By a vote of two to one the Commission sustained the specification and required that the cement be held for 28 das. and the contractor was thus delayed in his work.

It is true that modern specifications require that there shall be no retrogression in the strength of the cement between the 7-da. and the 28-da. period and therefore this requirement would have been impossible to live up to, had the Commission waived its rights. On the other hand, if the cement's general record were known and this element of permanence assured by the previous knowledge of the brand, the Commission might have been justified in permitting the cement to be used upon the test at the shorter period, especially in view of the contractor assuming responsibility.

Concrete Stone

WHEN an architect finds manufactured concrete stone "more satisfactory than natural stone" for a work of the magnitude and importance of the new building of the Delaware and Hudson company at Albany, and says so, as Marcus T. Reyonlds does in his contribution, p. 289, it is too much to expect that the occasion shall pass unnoticed. Repeated evidences of approval of concrete stone for architectural purposes, as published from time to time in these pages, show that this material is gaining important ground.

That" Ruff, Buff" Paper

THE buff, rough paper on which pp. 11 to 14 (advertising section—front of magazine) are printed, is used with the idea of displaying the Editorial wares. The section is used as a showcase so that you may discover quickly what the magazine contains of especial interest to you. It is an editorial ambition to make this magazine a piece of equipment for the practical man—a tool. The *Index Insert* is the handle for that tool. Whether or not the idea of the *show-case* or the *tool handle* or, more plainly, that of a *Ready Reference Index* appeals to you, it is to be hoped the new feature (now in its third month) will give the intended result.

Use the Ballot

THERE is a ballot at the bottom of p. 13 (see the "ruff, buff" paper in the front of the book) and to get the greatest possible value out of this magazine you should vote at once and mail your ballot. We have definite knowledge of the professions, occupations and special lines of work of about 70% of the readers of this magazine, but that isn't all the information the editors need to be of the greatest possible service to the greatest number. The ballot, filled out by every reader, would be the means of accomplishing a great deal in the way of individual service. You cannot lose in such a contest. There can be no defeated candidate. Everybody's preferences should be known, to be acted upon.

The Matter of Air Space

AND while you are answering inquiries, why not contribute something to the sum of knowledge on the subject of insulation as discussed under the heading "Good Practice in Concrete Block House Construction," p. 305? Most builders decided years ago that, to make sure of a good job, interior plastering should be applied direct to the wall, without furring, *only* when the wall afforded insulation in a continuous air space. This is entirely aside from the matter of a waterproof wall. That depends upon the density of the concrete and in block construction upon the mortar joint, yet now there appears to develop an honest difference of opinion. The questions are: "In a climate in which there is to be a wide difference in temperature between the inside and the outside of a house, is it good practice to apply plaster direct on the interior surface of exterior walls, where a continuous air space is not provided in the wall construction? What has been your experience? What do you know of such construction in cases in which interior condensation did or did not develop as a result of having no insulation?"

Concrete Armor Plate

ON the principle of necessity being the mother of invention, it is interesting to note in these war days that concrete armor plate for warships is being seriously contemplated and, in point of fact, according to tests recently made at Muggino, Italy, the superiority of reinforced concrete over steel armor plate in resistance to artillery fire has been definitely proved. Earlier tests at Spezia Harbor showed excellent physical results where a vessel covered with concrete armor plate was rammed by an armored warship without causing any serious injury. From this latter experiment conclusions are drawn that a vessel so protected would resist the attack of submarine torpedoes and also might be immune from damage by mine explosions.

Edmond Coignet Dead

In a recent number of CONCRETE-CEMENT AGE, the death of Armand Considere, one of the great French scientists in the field of concrete construction, was announced. Following closely upon this sad event, comes the death of Edmond Coignet, another of the great pioneers in concrete construction in France. Mr. Coignet began as an engineer, studying at the Ecole Centrale in Paris. He was the originator of his well known system of reinforced concrete and was not only an eminent engineer for works in that material, but was also thoroughly versed in the other branches of engineering. Well known as an inventor and a man of great practical experience, he possessed also very considerable knowledge as a theorist. It was through him that the Paris County Council adopted his system for the construction of the large sewer near Paris and it was also his construction that was largely used in works of the Suez and the Panama canal. But most celebrated was the monumental waterworks at the Paris Exposition of 1900, known as the Chateau d'Eau, for which he was awarded the Grand Prix and a gold medal. Mr. Coignet had a most charming personality and was not only distinguished as an engineer, but was also largely associated in banking and other important enterprises in France.

Decrease of Production of Portland Cement in 1914

The total production of Portland cement in the United States in 1914, according to Ernest F. Burchard, of the United States Geological Survey, was 88,230,170 bbls., valued at $81,789,368; the production for 1913 was 92,097,131 bbls., valued at $92,557,617. The output for 1914 represents a decrease in quantity of 3,866,961 bbls., and a decrease in value of $10,768,249. The value assigned to the production is computed on the basis of 92.7 cts. a bbl., or the average value of the Portland cement shipped in 1914. A summary of the advance statement of the Geological Survey follows:

> The shipments of Portland cement from the mills in the United States in 1914 amounted to 86,437,956 bbls., valued at $80,118,475, compared with 88,689,377 bbls., valued at $89,106,975, shipped in 1913. This represents a decrease in quantity of 2,251,421 bbls., and in value of $8,988,500. The average factory price per bbl. in bulk for the whole country in 1914 was 92.7 cts., compared with $1.005 in 1913, a decrease of 7.8 cts. a bbl. This price is about 11.8 cts. higher than the average price in the Lehigh district and is near the average price in New York, Illinois, Iowa, the Southeastern States, and the Plains States, but falls 42.5 cts. below the average price received in Utah, where Portland cement brought the highest figure during the year.
>
> Among the States there were unimportant changes in rank as cement producers. Pennsylvania and Indiana held first and second places respectively, as for many years, but both of these large cement-producing States suffered an appreciable reduction of output. In 1913 the output of California exceeded that of New York and Illinois, but in 1914 this State dropped from third to fifth place. New Jersey dropped from seventh to ninth place, having been passed by both Michigan and Iowa in 1914. The State of Kansas, which has attracted considerable attention in the cement world, first because of the rapid development of the industry within its borders on account of the proximity of abundant supplies of suitable raw material and cheap natural gas, and later because of the waning of the gas supply and the consequent increase in cost of manufacture of cement which resulted in curtailment of output, maintained its rank of tenth among cement producers and suffered but little reduction of output, although the price of cement here fell considerably below the average. Iowa and Onio both showed gratifying increase in output and appear also to have kept prices up more successfully than many other States. In the far West, in Washington, conditions were brought into better balance by a considerable curtailment of production and an increase in shipments, although prices fell heavily; in Utah production was largely and shipments slightly increased, and prices were also increased. The only other States showing increase of prices were New Jersey and Texas.

Design and Construction of the Gantner-Mattern Co. Knitting Mill at San Francisco

By E. F. Cykler[1]

That San Francisco is keeping abreast with the best in business and building practice is exemplified in the construction of the most complete and modern knitting mill in the world. It also typifies the growing tendency of industrial men to have their establishments housed in up-todate fireproof buildings. This was accomplished by the Gantner-Mattern Co. when it built its new mill on Mission St., between 10th St. and 11th St. Various types of fireproof construction were examined and discussed before the present plans were formulated. Economical plant layouts, lighting, good and healthful environments for employees, fire precautions and other details also received due consideration in planning this well balanced building.

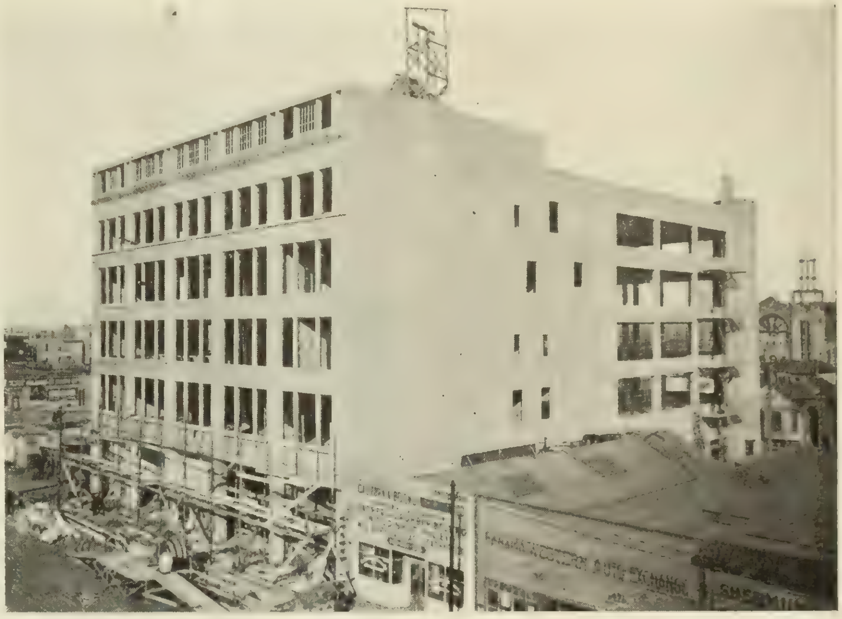

Fig. 1—General View Gantner-Mattern Building

GENERAL DESIGN

The building is of reinforced concrete construction throughout, six stories and a basement in height, and coverers an area of 103′ frontage on Mission St. and Minna St. by 160′ in depth, as shown in Fig. 1.

The basement height is 11′ from floor to floor, the first story height 19′ 1″, the second, third, fourth and fifth story heights are 13′ 1″, and the sixth story, comprising the sun room and lunch room for the employees and for their entertainments, is 10′ above the main roof.

Lighting.—Proper lighting was one of the main considerations in planning this building, as the greatest portion of the work done in a factory of this type requires the best of illumination. The fifth floor contains the knitting machines and to illuminate these properly sawtooth skylights were placed over the center portion of the fifth floor, as shown in Fig. 4, and a detailed section in Fig. 6. Across the entire space between columns and floor beams were filled with Fenestra steel sash[2] and wire glass. The Mission St. front was made as open as architectural treatment allowed, as shown in Fig. 1.

The materials used in manufacturing are brought from the basement storage or from the street direct to these knitting machines, situated on the fifth floor, by means of a large freight elevator. From these machines, the products gradually work their day down by a series of chutes from floor to floor, becoming more and more nearly a finished product as they go.

They are marked and boxed ready for shipping on the third floor. The second floor is used for storage of finished goods. Part of the first floor is also used for storage of both finished goods and raw materials.

In designing this building the utmost in economy was aimed at, and to obtain this, simplicity and straightforwardness in design were given thorough study. Another feature that must not be overlooked in getting a low figure on this work was the completeness of the plans, and all special features were completely detailed. Nothing was left for the imagination of the contractor and therefore close bidding was the result, and when I say that the complete concrete work was finished at a cost of 4¾ cts. per cu. ft. of building, it shows that the extra work in the office to make the plans complete in every detail was more than justified, especially as there were no "extras" on the job.

Fireproofing.—Special care and attention were also paid to the fireproof features of this building, and all interior partitions were constructed either of 4-in. concrete walls or of hollow terra cotta tile, as can be seen in Fig. 1 showing terra cotta office partitions on the third and the fourth floor. Fenestra steel sash[2] and wire glass were used for all windows, as previously mentioned. The entire building is equipped with an automatic sprinkler system and each floor is cut off from the other floors by placing wooden doors, covered with sheet metal as prescribed by the Fire Underwriters's Specifications, at the entrances to the stair well. The elevator doors are of metal and wire glass. Every possible precaution was taken against any accidents due to fire. All stairs are constructed of concrete.

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[1] Prin. Asst. Engr., H. J. Brunnier, Cons. Struct. Engr., San Francisco

[2] Detroit Steel Products Co., Detroit

DETAILED DESIGN FEATURES

Foundations.—Foundations of this building were designed for dead load pressure only. Before adopting a safe bearing value for the soil, borings were made in various places on the site to determine the materials underlying the excavation.

The maximum soil pressure allowed for dead and for live load combined was 3 tons per sq. ft.

The foundations were then designed as shown in Fig. 7. Along the two side walls the columns were carried on combination footings. Footings for Cols. 9-10-15-16 were designed to carry in addition to the floors, sprinkler pressure tanks and a storage tank.

The material excavated was at first good clear sand and further down sand with a small amount of stiff blue clay.

As seen in Fig. 8 the steel in all footings was specified to be suspended from above and to provide for at least 3″ of concrete under all steel. It also shows good spacing to allow free flow and bonding of concrete.

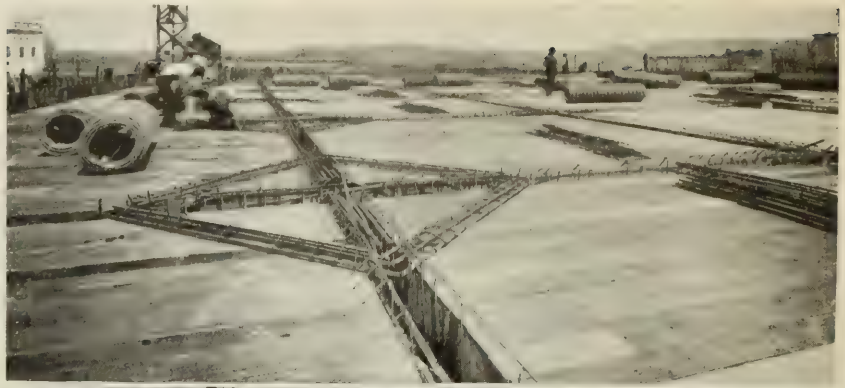
Walls.—The basement and the retaining walls are dense concrete and no waterproofing materials were added. During heavy rains last winter there were no signs of moisture in the basement. The retaining walls were designed as flat slabs reinforced in two directions to carry the pressures.

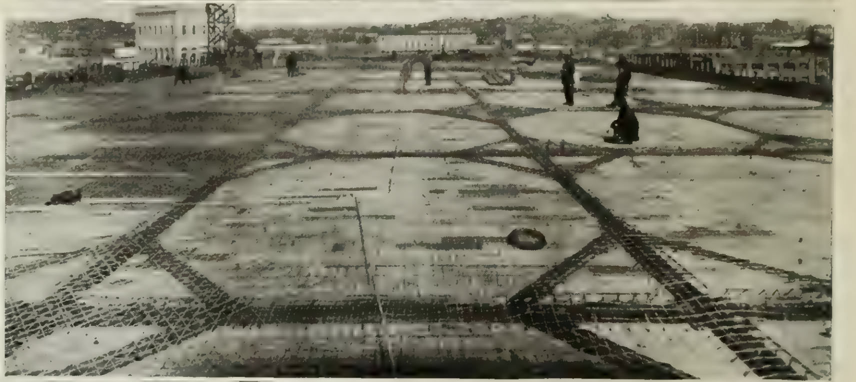
Floor Systems.—In the preliminary work of design of the floor systems three types of construction were investigated, viz:

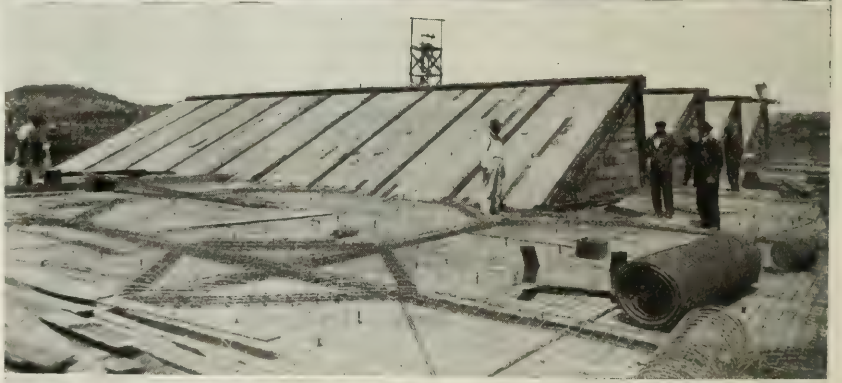
(1) Three-beam and girder type.
(2) One beam framing in at center of girder.
(3) Square panel system, both Kahn[3] and Chew[4] systems.

It was decided that the three-beam and girder type was the most economical of the three and the most advantageous for the live loads required and column spacing.

The Chew system was used in the fifth floor and the roof for machinery clearance and shafting. This system is figured on the theory of circular plate action, and its details of construction are clearly shown in Figs. 2 and 3. The small diagonal beams, same depth as the slab, around columns, are tangent to this circle. This type of construction gives the same size of beam on the four sides of a square panel.







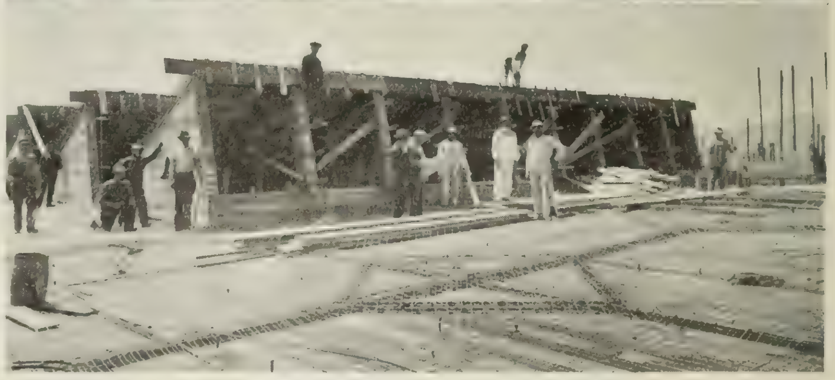


Fig. 2—Roof Forms in Place Showing Reinforcing Around Column Heads

Fig. 3—Roof Forms Ready for Concrete; Note Wire Fabric Slab Reinforcing

Fig. 4—Detail of Sawtooth Roof

Fig. 5—Forms in Place for Sawtooth Portion of Roof

The second to the fifth floor have wood sleepers embedded in concrete and wooden floors. This allows the location and relocation of machines at any time as they are well balanced and can be thoroughly held by lag screws.

Fig. 10 shows a part of the second, third and fourth floor framing plan and is typical for the first floor.

Roof Framing.—Figs. 4, 5, 6 and 14 show the complicated roof framing and sawtooth construction in the central portion and sun room framing on the Mission St. front. The Chew system as seen in Figs. 2, 3, 4 and 5 was used here also. The part of the roof outside the sawtooth is cement finished and nicely fitted up with plants, flowers and benches where employees can enjoy themselves at the noon hour.

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[3] Trussed Concrete Steel Co., Youngstown, Ohio

[4] R. S. Chew, Rialto Bldg., San Francisco

In the sun room is a cafeteria run by the owners where lunches are sold to employees at no profit.

Spandrels and Mullions.—Figs. 11 and 13 show details of spandrels and mullions on Mission St. The architectural pilasters were made use of as columns and the spandrels as beams.

Stairs.—The stairs are of rein-

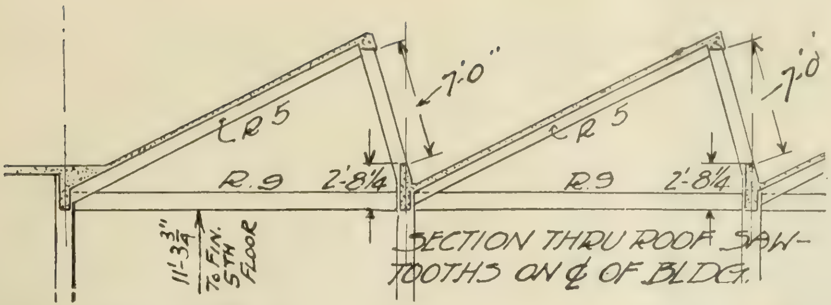


Fig. 6—Detail of Sawtooth

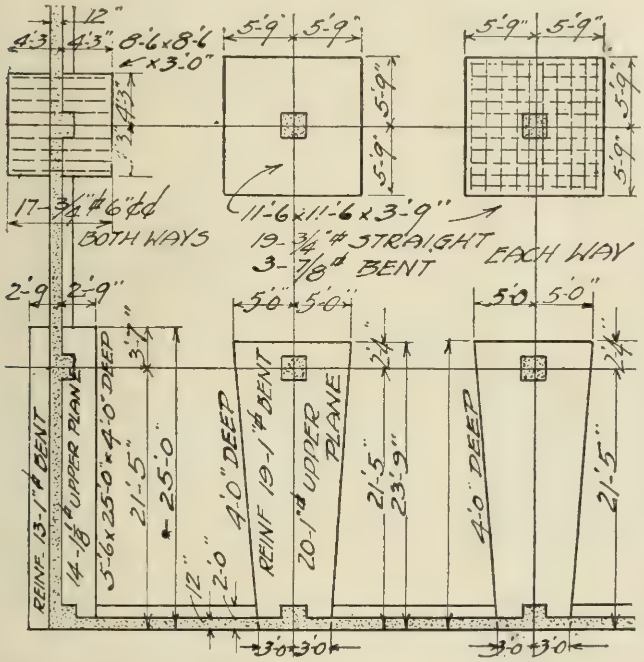


Fig. 7—Detail of Footings

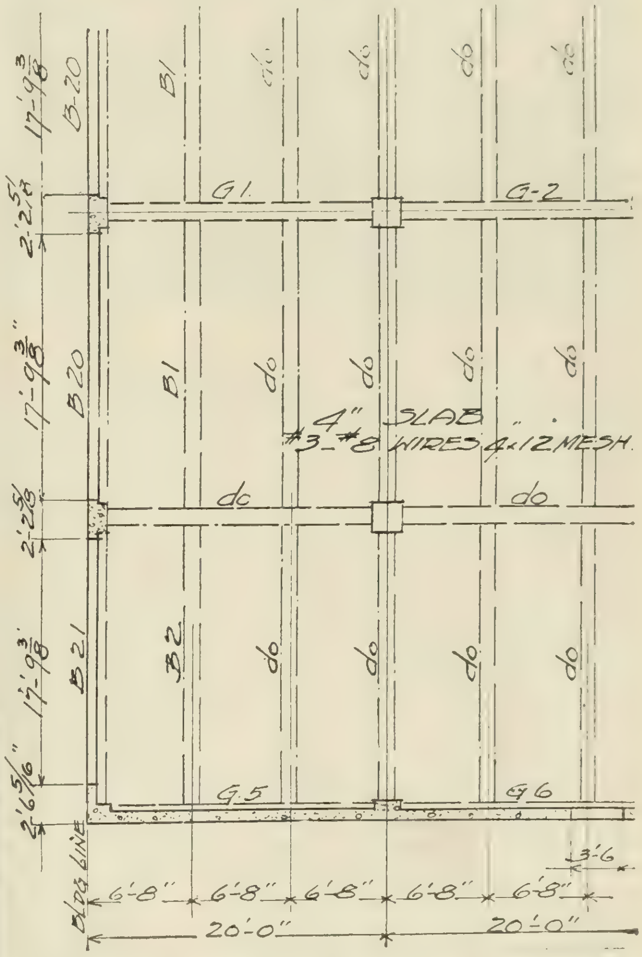
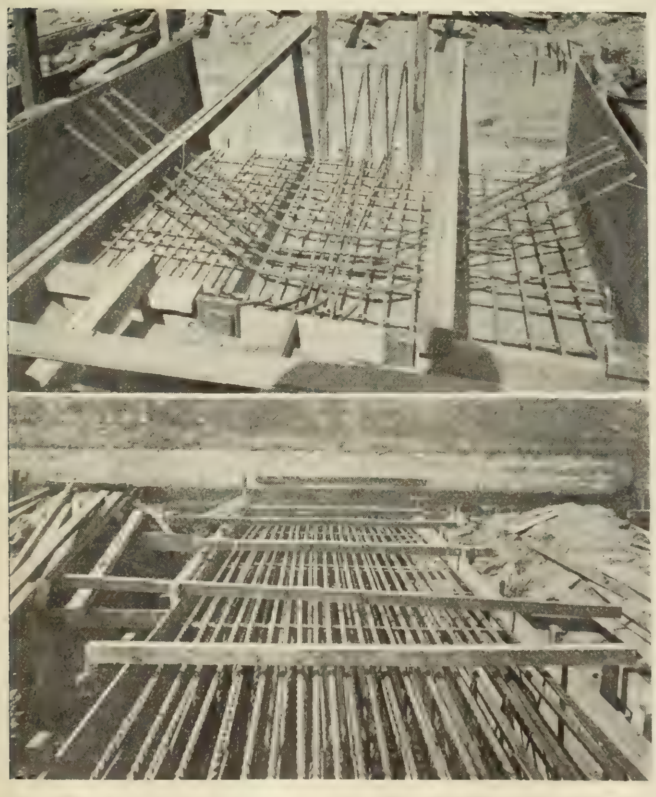


Fig. 10—Typical Second, Third and Fourth Floor Framing



Figs. 8 and 9—Reinforcing for Footings in Place

Note method of suspending rods in Fig. 8

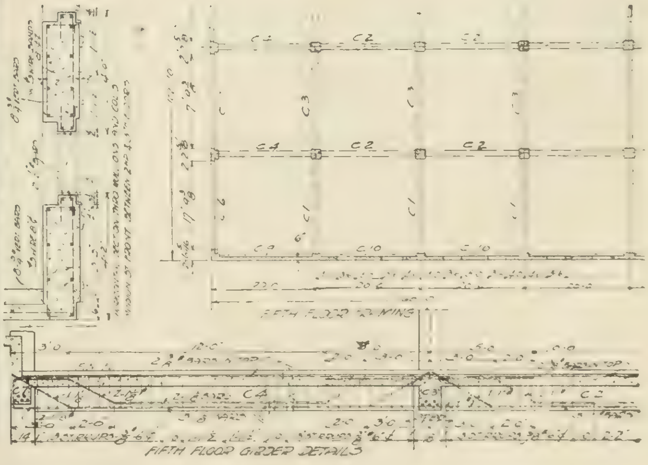


Fig. 11—Typical Fifth Floor Framing Showing Column Girder Details

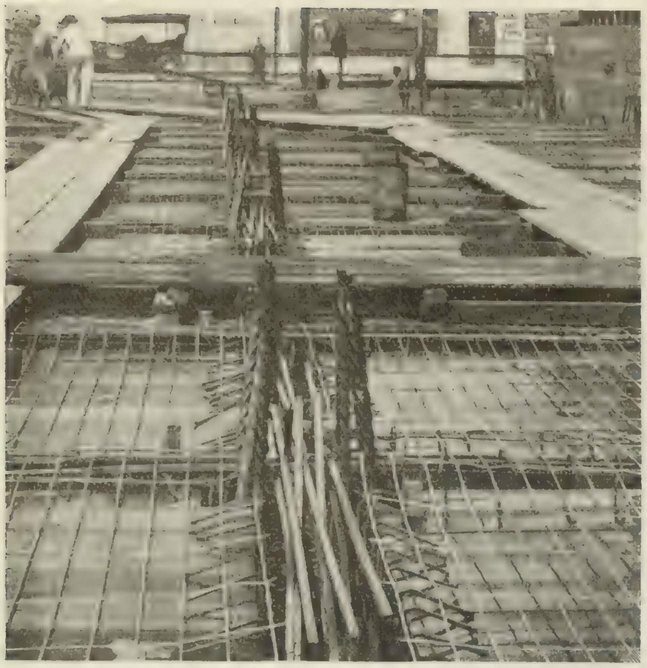


Fig. 12—Details of Reinforcing

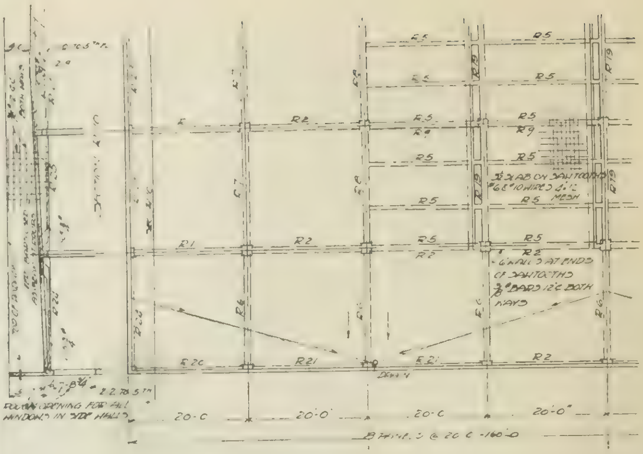


Fig. 14—Plan of Roof Framing.

forced concrete with a cement finish and 2-in. continuous rough concrete balustrade finished with ½-in. plaster, making a very rigid piece of construction.

Loads.—Before going into the design in detail, it may be well to enumerate the loadings used on the various floors.

Live load 125 lbs. per sq. ft. (all floors to slab and beams).

Live load 30 lbs. per sq. ft., roof slab and beams.

Live load 100 lbs. per sq. ft., all floor girders.

Live load 20 lbs. per sq. ft., all roof girders.

To columns live load on roof, 10 lbs. per sq. ft.

To columns live load on fifth floor, 100 lbs. per sq. ft.

To columns live load on fourth floor, 95 lbs. per sq. ft.

To columns live load on third floor, 90 lbs. per sq. ft.

To columns live load on second floor, 85 lbs. per sq. ft.

To columns live load on first floor, 80 lbs. per sq. ft.

All exterior 6-in. curtain walls finished with plaster were figured at 80 lbs. per sq. ft. Window openings were deducted and figured at 20 lbs. per sq. ft. for metal sash and glass.

The dead loads on all floors were:
75 lbs. per sq. ft. to slab.
100 lbs. per sq. ft. to beam.
115 lbs. per sq. ft. to girder.

Unit Stresses — The maximum stress allowed for the concrete in beams and girders was 700 lbs. per sq. in. and for steel in tension 16,000 lbs. per sq. in.

Columns were designed for 750 lbs. per sq. in. on the inner core and the percentage of vertical steel used was not over 4% and not under 1%.

Reinforcement. — The shear in beams and girders was taken up partly by bending the main reinforcing members and partly by ⅜-in. x ⅜-in. stirrups.

All the reinforcing in the beams and girders as shown in Fig. 12 is held up in the forms by the stirrups bent in such a manner that the ends of these rest on the forms. In the tops of all beams fastened to the stirrups are two ⅜-in. x ⅜-in. bars which hold the floor fabric in position over supports. Standard usage was followed in spacing the bars in beams.

Two ½-in. x ½-in. bars were specified around all openings in the floor slabs. These bars were to run between supports. All window openings had two ⅜-in. x ⅜-in. bars specified around all sides as a precaution against cracking in the corners.

Each plan contains a complete beam and girder schedule, giving size of beams, size and number of main reinforcing bars, size and number of stirrups and disposition of the steel by referring to typical sections or details.

Fabric notes were specified as follows, being placed on each plan to call the special attention of the workmen:

All side laps of fabric must be one mesh wide. End laps must be over supports and have at least 24-in. lap, i. e., each end to run 12″ beyond the center line of support. Ends of fabric at walls must extend at least

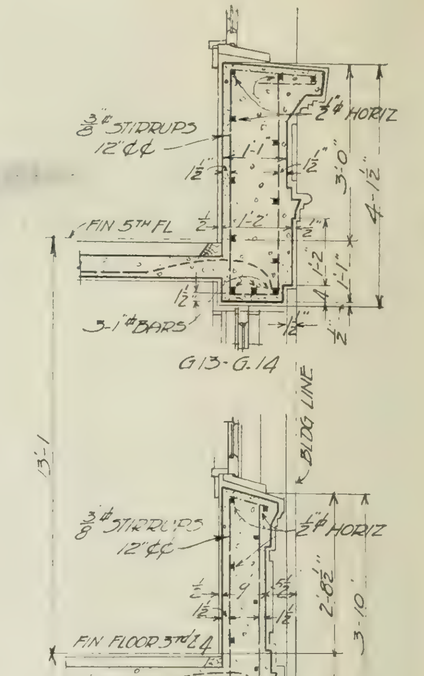


Fig. 13—Typical Wall Section

to within 3″ of outside face. Fabric must be kept up over supports within ¾″ of the top of the slab.

The vertical bars in columns are banded with ⅛-in. by 1-in. bands riveted with two ⅜-in. rivets. The column bars are spliced at each floor where the column size remained the same, but the reinforcing changed, sufficient bars were run up to develop the column above. Where the column size changed, dowels were placed to develop the column above. All dowels are 4′ long except for 1¼-in. bars, and there are 4′ 6″ long. The steel in all columns is protected with 1½″ of concrete fireproofing.

EXCAVATION

The excavation was a sub-contract at $5,450, and included taking out and hauling away 6,000 cu. yds. of sand. The sand excavated from footings pits was found to be suitable for use and was stored and used.

MATERIALS OF CONSTRUCTION

Santa Cruz Portland Cement[5] was used throughout the building and it was found to pass the requirements of the Am. Soc. for Test. Mat. Total quantity of cement used was about 7,200 bbls. The cement cost $2.30 per bbl. with a rebate of 40 cts. per bbl. for sacks returned.

It is an interesting fact that the actual rebate received was 35 cts. per bbl., showing a sack loss of 12½%.

The gravel used was bought by rail from Niles Canyon and was a well graded, hard, dense gravel, varying in size from ⅜-in. to 1¼-in. maximum, containing practically no silt and with a very small percentage of flat or elongated particles. The gravel cost $1.20 per cu. yd. delivered.

Sand was obtained from the Ocean Shore Sand Co., the pit being so called because located on a railway line of that name. This sand is well graded, all passing a ¼-in. screen, but lacks a little in smaller sizes, therefore a small percentage of fine sand found on the building site, which is of a uniform size, was added.

The aggregate was proportioned according to Fuller's formula, using the straight-line method and had from 15% to 17% voids.

CONCRETE WORK

Proportions.—The concrete was made in the proportions of 1 part Portland cement, 1½ parts Ocean Shore Sand Co.'s sand, ½ part fine sand taken from excavation and 4 parts gravel.

Careful tests and thorough inspection were given the concrete in all stages of construction. The concrete specimens for crushing were made in tins 6″ in diameter and 8″ high. These samples were taken frequently during construction, and compressed at an age of 28 das. They developed an average strength of 2,200 lbs. per sq. in.

The concrete in place cost, including cement, sand, gravel, water, power and labor, $5.50 per cu. yd.

Reinforced concrete completed, including all materials and labor, cost $14.20 per cu. yd. The total cost of concrete was $68,500.

FORMS

Forms for the concrete work were made of wood and were designed for the load they were expected to bear and nothing was left to guess-work. The lumber used was Douglas fir, surfaced to uniform thickness. Where plastering was to be done the lumber was left in the rough and the rough face turned toward the inside so as to leave a suitable bond.

All vertical shores rested on shims which were driven up tight each time before pouring a floor above. Shores were placed under beams and girders only. The forms were so constructed that beam sides and slab forms were removed without disturbing the supports. These supports remained in place long enough to have the weight of green concrete floors carried by at least two floors which had been placed not less than 28 das. Forms under non-bearing members were removed in about 2 wks.

Carpenters received the union scale of 62½ cts. per hr. and laborers and helpers 31⅓ cts. per hr., there generally being one helper to two carpenters. The labor cost of erecting forms was $1.50 per cu. yd. or 5 cts. per sq. ft. Wrecking labor cost 15 cts. per cu. yd. and ½ cts. per sq. ft.

REINFORCEMENT

Figs. 2, 3, 8, 9 and 12 show the manner of placing the reinforcing steel in footings, floors and roof. It was wired firmly in place to prevent any displacement while concreting. Small beveled concrete blocks with wires embedded in them for fastening to bars were used as spacers at beam bottoms and sides.

With housesmiths at 75 cts. per hr. and foreman at 87½ cts. per hr., the cost of bending and placing reinforcing steel amounted to $12 per ton.

Reinforcing steel was principally in the form of corrugated bars, although some square twisted rods were used; 390 tons of steel were required. There were also 29 tons of Clinton wire fabric[6] used.

Detailed steel drawings were made and the steel came on the job cut to length and was bent on the job by hand-operated machines.

PLANT LAYOUT

The sidewalk on Mission St. was omitted until the building was completed, and bins were built in the areaway with a temporary driveway containing trap-doors over the bins. Materials as they came to the job were easily dropped into the proper bin.

The mixer, a ¾-yd. Smith batch mixer,[7] was located in the basement near the bins, and in the well of the future passenger elevator were located an automatic dumping elevator and skip. The mixer dumped directly into the skip and received its charge directly from the gravel bin, making a very economical system of handling. The elevator deposited the concrete into a hopper at the floor where needed. It was taken by Sterling No. 3 two-wheeled dump-carts[8] and wheeled to the required point. All wheeling was done on plank runways laid on saddles, arranged so as not to disturb the reinforcing.

The structural cost was 4¾ cts. per cu. ft. of building, measured from the top of the basement slabs to average roof height. The total cost of finished building was $130,000 or 9 cts. per cu. ft.

Lindgren & Co. were the general contractors on this building, with Geo. W. Kelham as architect and H. J. Brunnier as structural engineer.

College students in the large universities of the country are being furnished with important information on concrete and its use by various experts from the leading cement plants. Lectures are given to the students, illustrated with moving pictures showing the process of the manufacture of cement and in some cases of the general construction of silos and other buildings built of concrete. The college boy thus starts in his life's career thoroughly equipped with a knowledge of this most important building material and while, sad to say, some of the experts who lecture to them found difficulty in answering some of the pointed questions fired at them by the college lads, the result on the whole is beneficial and instructive.

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[5] Santa Cruz Portland Cement Co., San Francisco

[6] Clinton Wire Cloth Co., Clinton, Mass.

[7] T. L. Smith Co., Milwaukee

[8] Sterling Wheelbarrow Co., 6475-6500 Pullen Ave., Milwaukee, Wis.

Investigation of the Effects of Alkali on Concrete Drain Tile Near Lake Park, Ia.

By Charles E. Sims[2]

The effect of alkali on concrete has been a matter of so much concern to many users that the writer presents his experience with it in the case of a line of 22-in. drain tile near Lake Park, Ia. This experience may throw little new light upon the general subject of alkali action on concrete to those who have studied the subject closely but it may assist pipe manufacturers in producing suitable pipe for alkali conditions. The coming extensive use of concrete sewer pipe of all sizes is to be a successful industry if the effects of alkali on concrete are understood and the means taken to make them proof against it. Irrigation pipe and drain tile must come in touch with alkali, at times known and at other times unknown to the manufacturer and user, but it is at all times possible to manufacture these pipe and tile so that no fears need be entertained as to their permanence.

The history of the case in point is as follows: The writer was manager of a well equipped concrete tile factory when in 1911 he secured the contract to furnish the tile for Dickinson Co., Ia., Drainage Ditch No. 15. The location of this ditch was in the so-called Black Swamp, three miles south of Lake Park, Ia. The outlet tile were 26-in. diam., decreasing in size through the swamp toward the upper end. Two thousand, two hundred feet of 22-in. tile and 400′ of 24-in. were designed to be laid through the lowest part of the swamp. Many tile laterals entered this main and usually where the main tile changed size. The outlet tile emptied into an open ditch and about 100′ below the tile outlet a natural gully draining several hundred acres of land came into this open ditch. The area of the Black Swamp itself was nine sections of land, of which perhaps one section was under water, naturally, most of the time. In this swamp there was nothing to attract the ordinary observer to any particularly interesting or peculiar soil formations and the vegetation was not out of the ordinary. No evidence of any large quantity of alkali was apparent. The manufacturer thought it was up to him to make a pipe of average good quality; he thought that he had as good as the average facilities for machine manufacture and necessary curing, and went ahead to make the pipe. It was, however, his first experience with a power tamp machine for sizes of tile as large as these and his first experience in shipping such sizes. A million feet of smaller sizes had been made and successfully used. There had been no experience with these with harmful effects from alkali.

The contract was taken in the summer of 1911, the 22-in. tile were made in the latter part of Oct. and first few days of Nov., in cold weather. Shipments to the ditch were made about 20 mi. in box cars and 3 mi. by wagon in the fall and the winter months. The tile were made of 1 part cement to 4 parts sand, with enough water to make the materials damp but not wet enough to leave watermarks on the tile when the jackets were taken off, as is required in present day specifications. It was impossible to tamp the concrete with the machinery then available with a larger amount of water. The tile were cured 3 das. and watered each day, the temperature ranging in the curing room from 50° at night to 80° in the day time. Steam was run into these rooms from the engine exhaust through water in wells located in various parts of the curing room floor. The cement was of unquestionable quality. The sand was from a bank, not objectionable from any standpoint. A few tile were made out of lake sand which was too rounded and too much the same size to be first-class but no further reference need be made to this fact since the effect of the alkali seemed equally destructive on the concrete from both sands. A continuous mixer was used which it was impossible to regulate without a variation in the proportions of from 1:3¼ to 1:4½.

The tile were laid in Feb. of 1912 after the engineer for the county had tested each tile by eye and with a hammer. The writer did not see the tile laid but has since learned that in spading, chunks of white substance shaped like pebbles were cut through in large quantities and that the workmen called the soil peat. Tile were laid at a depth of 7′ and covered with the bottom spading. In early fall of that year a lateral was cut into the 22-in. tile and a workman notified the writer that the concrete of these tile seemed to cut easily and the tile were cracked, where he cut into the line lengthways, into quarters so that the top had settled down 1″ to 2″. With the engineer the writer investigated and found that the condition represented was typical of the entire line of 2,200′ of 22-in. and the 400′ of 24-in. tile, and that these tile were cracked not only longitudinally in most instances but minutely into irregular pieces. The tile were coated on the inside with a limelike deposit which was very thin at the top of the tile and thickened below that until it formed a shelf the width of one's hand at the water, which was 4″ to 6″ deep. Some of this deposit was hard and some was soft, but it was all white in color. The investigators were not certain whether this was alkali or whether this case fulfilled the competitor's widely advertised claim that the "cement in concrete tile would dissolve and leave a mere streak of sand." We called upon George P. Dieckman, chf. chem. for the Northwestern States Portland Cement Co. The chemist's report is attached.

After having determined upon the cause of the difficulty the writer waited until the fall of 1913 before replacing the disintegrated tile. There were some tile found in this line which had not suffered the fate of the others and it was noticed that these specimens were the densest concrete. The tile were carefully watched and it was noticed that after the spring rains of 1913 the deposit in the tile had almost all washed out and the tile were in better condition than the first season. As a water-carrying channel these tile had not failed to serve their purpose and it seems likely that had the tile not been investigated up to this time no difficulty would have been apparent. While the concrete was broken up by the hair cracks so that it was easy to complete the fracture, and while most of the tile had weakened enough to cause them to break longitudinally, still the circular shape was maintained and it is a question whether or not collapse would have occurred as long as the earth supported the arch all the way around. However, the tile had failed during construction, that is, before the completion of the contract, and new tile were demanded. An examination of the entire main line and the laterals showed no sign of disintegration in either 1912 or 1913 except the tile originally noticed. This fact may be explained by the statement

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[1] Pasadena, Cal.

that the laterals passing through the same soil as the 22-in. tile were made of richer proportions and a wetter consistency—being made on a different machine which required a more plastic material the the one formerly used. The lower end of the main was not affected by the salts because there was little water to percolate through them in the higher ground and because they were made with richer proportions than were the 22-in. tile.

The new tile were made of 1 part Portland cement, of the same brand as before, to 3 parts of sand from the same bank as before, but with more care to eliminate the loam and clay, and water enough to show when the jackets were taken off the tile, this being done immediately after the tile had been run into the curing rooms. The machinery was improved by the addition of a second tamping device and the tile were cured for three full days with steam turned into shallow wells day and night so as to maintain a uniform temperature of 80° to 90°. These tile were made in Sept. and Oct. so that they aged after leaving the curing rooms under favorable temperatures for hardening until shipped in Nov. and Dec. It is the writer's belief from investigations made that all necessary precautions were taken up to this point, However, the tile were rolled through a shallow trough filled with water to which cement had been added until a milky fluid had been obtained and the tile were thus coated inside and outside. This was done almost as soon as the tile were taken from the curing rooms and the tile were then kept wet for several days. The coating served to glaze the tile and no doubt filled the pores wherever they existed. Little breakage resulted in shipping and hauling. The tile were laid in the fall of 1913, and have served their purpose fully.

It is safe to say, having studied for several years the subject of alkali vs. concrete and having followed the reports of a number of instances of the kind, that the manufacturer who uses good materials in proper proportions to make dense concrete and who compacts it well and ages the product for a month, at a temperature above freezing is on the safe side, while he who does not pay attention to these things runs some risk of attack from alkali, should the product be placed where it is subject to it. I should add, however, that modern machinery is compacting concrete better today than it did only a year or two ago, so that much of the danger of porosity is removed. Knowing that concrete becomes more dense with age it seems that if the absorption is less than 5% in concrete 30 das. old it ought to be alkali-proof and suitable for any service. In fact it has proved so in sewers and in alkali regions to an extent which is absolutely convincing.

THE REPORT OF CHEMIST'S INVESTIGATION

By Geo. P. Dieckman[2]

The investigation reported herein was carried on to determine the cause of the failure of a concrete tile line in a ditch near Lake Park, Ia., known as the Dickinson Co. Ditch No. 15. This ditch was designed to drain nine sections of swamp land, the sizes of tile ranging from 26-in. nominal diam. at the outlet to 6-in. in the laterals. Disintegration was found in the 22-in. and 24-in. sizes on the main line and the following procedure was adopted by the chemist in his investigation:

1. Examination of the soil at the drain.

2. Examination of the ground water. Eight samples were taken from the lateral drains, from the main drain where the disintegration occurred on the 22-in. tile, from the outlet of the 26-in. tile and three more samples from drains a few miles east and a few miles west of ditch No. 15.

3. Examination of the white deposit found on the inner surface of the tile above the water line.

4. The chemical examination of the concrete of the tile:

(c) The tile as made and delivered by the manufacturer, samples being taken from tile found on the ditch side but not used in the ditch.

(b) The 22-in. tile, under water line.

(a) The 22-in. tile, above water line.

5. Physical condition in regard to the strength, density and age of the tile.

6. Conclusions and means recommended for preventing failures in the future.

Referring to No. 1; Examination of the soil: The area drained has long been known as the Black Swamp. It is surrounded by rolling land, the hills containing gravel with the clay. The soil in the swamp consists of a gummy, sandy clay, overlaid with decayed vegetation, several feet deep.

Referring to No. 2; Examination of water: Note the results of tests in the accompanying table. The analysis of No. 1 specimen of water, which was taken from a swamp 2 mi. east of the Black Swamp, and that of Nos. 5 and 6 which were taken 7 mi. west of the Black Swamp show the prevalence of alkali in the surrounding territory. Specimens Nos. 1, 5 and 6 were taken in separate drainage basins and these basins have no connection with the Black Swamp. Specimen No. 2 was taken from a lateral flowing into the main tile from the west and No. 4 from a lateral flowing into the main from the east. Both laterals were 8-in. tile lines at a depth where the sample was taken of approximately 4′. Both No. 2 and No. 4 show a high amount of salts or residue and both are almost of the same composition—220 gr. to 245 gr. per U. S. gal. was found as the total residue, which indicates an extremely bad water. Ordinary water usually contains 30 gr. to 50 gr. The total residue of these two specimens contains 68% and 84% calcium and magnesium sulphate, both of which elements are very destructive. The amount of alkali in these waters is small. Specimen No. 7 was taken in the 22-in. tile line. Is shows over 216 gr. residue per gal. The amount of calcium sulphate in this specimen is lower than in waters No. 2 and No. 4, but is considerably higher in magnesium sulphate. This water also contained free hydrogen-sulphate gas, which is converted by oxidation to sulphuric acid. The total amount of sulphate may be about 60% of the total residue. The amount of sodium sulphate is higher in this water than in the other waters. Sodium sulphates are alkalies. Calcium sulphates are destroying agents. Magnesium sulphates, sodium sulphates and sulphuric acid are still more dangerous and more destroying elements, since they crystallize with much more force. It is the crystallization and expansion of the destroying element in the process of crystallization which disrupt the concrete and cause the disintegration. (The volume of the destroying element increases as much as 10-fold after changing from the soluble condition to the crystalline.)

Sample No. 3 was taken from the 26-in. tile at the bulkhead outlet. A ditch entered the main ditch just below the outlet of the 26-in. tile and sample No. 8 was taken from it. Water No. 3 contained 138.8 gr. and No. 8 contained 108.9 gr. residue per gal., which is approximately 50% less residue than was found in samples No. 2 and No. 7—(showing the probability that the worst soil

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[2] Chf. Chem., Northwestern States Portland Cement Co., Mason City, Ia.

Analysis of Specimens of Ground Water

	Ditch No. 16, 2 mi. E. of No. 15. No. 1	Ditch No. 15, from 8-in. lateral at Sta. 55 No. 2	Ditch No. 15 at Outlet No. 3	Ditch No. 15 from 8-in. lateral at Sta. 65 No. 4	Osceola-Dickinson Ditch No. 1, surface No. 5	Osceola-Dickinson at outlet of 32-in. tile No. 6	Ditch No. 15, from 32-in. tile No. 7	Lateral below outlet of Ditch No. 15 No. 8
Na_2SO_4	4.805	5.481	4.805	1.982	0.075	4.140	14.695	22.685
$CaSO_4$	93.185	148.588	70.154	131.905	41.200	44.200	76.393	54.877
$CaCO_3$	......	....	3.796	....	....	....	....	....
Mg_2SO_4	51.884	4.723	....	45.546	6.648	....	62.050	....
Mg_2CO_3	16.911	39.656	44.437	42.863	6.473	6.939	31.433	8.057
NaCl..	Traces	Traces	Traces	Traces	Traces	Traces	Traces	Traces
Acid Silica.	28.924	21.227	3.324	2.449	0.081	1.866	22.277	2.216
Alumina ...	3.732	....	Traces	Tsaces	4.665	....	Traces	Traces
Oxide of Iron	......	....	Traces	Traces	Traces	....	....	....
Organic	32.191	25.420	11.718	41.405	16.970	12.654	9.563	13.996
	231.592	245.093	138.860	220.604	76.667	85.602	216.411	108.890

was in the lowest part of the swamp —where the 22-in. tile lay).

The samples No. 5 and No. 6 were taken from Osceola-Dickinson Co. Ditch 7 mi. west of the Black Swamp. They show 76.6 gr. and 85.6 gr. residue per gal., almost 75% less residue than in waters No. 2, No. 4 and No. 7, and 25% less than in waters No. 3 and No. 8. Sample No. 1 shows 231.6 gr. of residue, but this residue does not show such an extremely high amount of sulphate as in samples No. 2, No. 4 and No. 7 which were taken from the Black Swamp.

Referring to No. 3; Examination of the white deposit on the inner walls of the tile above the waterline: This deposit consists of calcium and magnesium sulphate salts from the soil water. The walls of the tile, acting like a filter, take out the salts and these crystallize on the inside surface of the tile as evaporation takes place. This deposit, as proven later by analysis of the tile, does not represent any salts from the concrete. This is a very important factor, proving that the concrete was not disintegrated by the filtration of the water, that is to say that the concrete had not formed itself into any soluble salts.

Referring to No. 4; Examination of the physical condition of the tile: Three samples of tile were obtained. The first sample marked *A* in the report, was disintegrated. It was taken from above the water line and was typical of the majority of the tile in the line. The second sample, marked *B* in the report, was hard and sound. It was taken from below the water line and was a typical specimen. The third sample was taken from a tile left on the ditch as an extra, is marked *C* in the report, and shows the quality of tile manufactured for this ditch. All three specimens were from 22-in. tile having a wall thickness of approximately 1⅞″.

The chemical analysis of the three specimens of tile shows a remarkably close chemical composition, with the exception of sulphate and magnesia. Specimen C, the original tile, shows .75% of sulphuric acid, equivalent to 1.07% sulphate. The specimen *B*, taken from under the water shows .85% acid sulphuric or 1.21% of sulphate—a small increase over specimen *C*. Specimen *A*, taken from above water, shows 2.51% acid sulphuric, or 3.12% of sulphate, a further increase. Specimen *A* shows an increase of three times the sulphate found in the original tile.

The amount of lime in these three specimens was: *C* = 23.52%, *B* = 24.68%, and *A* = 24.52%. This is practically no variation and shows that the swamp-water did not affect the lime in the cement.

The silica in *C* was 44.96%, in *B*, 44.76%, and in *A*, 4294%, proving that the sulphates have replaced silica in *A*. The magnesium in *C* was 3.44%, in *B*, 3.54% and in *A*, 4.36%, which shows that the disintegrated tile has increased in sulphate and magnesia and, as shown by the analysis of water No. 7, the water contained a high percentage of magnesium sulphates. These are highly destroying elements by reason of their great expansion while crystallizing. This analysis proves without doubt that the deposit found on the inside of the tile does not represent soluble salts from the concrete itself.

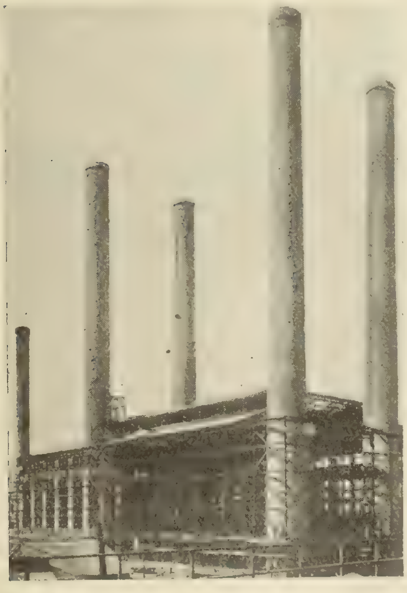
Tile subjected to such conditions as are found here, permitting the filtration of the soil water, become alternately wet and dry according to the rains on the basin drained and this deposit then forms in the concrete and on the inner surface above the water line. These repeated wettings and dryings concentrate the destroying salts, magnesium sulphates, in the concrete and their expansion causes the disintegration, the force exerted being greater than the strength of the concrete. Frost acts similarly on many materials.

Specimen *B*, taken below water, being constantly wet, did not disintegrate because crystallization could not occur under water, but there is no doubt that in dry season when no water flows through the tile crystallization and consequent disintegration will occur.

Specimen *C*, the original tile, was sound and hard and represented a good specimen of concrete. Specimen *C* was taken from a tile about 6 mos. old. The absorption test showed 6½% in 24 hrs. What the absorption was when the tile were laid in the ditch could not be determined, nor could the fitness of the tile be determined, as no tests were made for this at the time. All tile were tested by hammer and visual inspection by the engineer in charge. The manufacturer stated that the proportions were approximately 1:4, that the tile were shipped 20 mi. by freight, and hauled to the ditch—all in Oct. and Nov. of 1911 and Mar. of 1912. The tile stood some rough handling reasonably well, hence it seems reasonable to assume that the tile were of fair quality. That the tile were subjected to frost after leaving the steam curing rooms of the factory where they were given 3 das. curing probably retarded the hardening of the concrete and made them more vulnerable to attack by the destroying elements in the soil water. The tile not being well aged in favorable weather, and only 30 das. old when the temperatures were below freezing much of the time, not enough strength developed to resist the very severe test put on them in this ditch.

A tile, to be subjected to such conditions as were found in this case, must be made to meet these conditions. It will be necessary for the manufacturer to know that these conditions may arise at any time and he should test the locality of each job. A tile to meet such extraordinary conditions must be made more dense and by greater density more strength will be obtained. To obtain a greater density, a richer mixture must be used and of wet consistency. Of course, it is necessary that the aggregates entering into the concrete shall have proper physical qualifications and that neither the aggregates nor the water shall contain detrimental materials. More density is obtained by longer curing and aging. It is advisable to treat the tile with a wash of neat cement paint, or, better still, of neat waterproof cement paint. This can be spread on the tile as soon as the concrete is hard enough to stand handling and will produce a surface practically impenetrable. This extra precaution, of course, will be necessary only when the tile are to meet extraordinary conditions. The adoption of such a policy by the manufacturer will increase the use of concrete tile and help the growth of the industry.

Simple tests for acids, alkalies and for sulphates may be made by any manufacturer and are not expensive. Take two colors of litmus paper. Dip in the soil water a piece of the blue litmus paper and if this turns red you should conclude that the water contains acids. Try the red paper in the water and if it turns blue you may know that the water contains alkali. If the colors of the litmus papers are unchanged the water is neutral and safe. Almost all water contains traces of sulphates. To make these sulphate tests pour some of the water into a tall glass or glass tube sealed at the lower end, add a few drops of pure hydrochloric acid and then a few drops of a solution of chloride of barium. Your druggist can do it handily. If the water becomes clouded, or milky, in other words, there is a small amount of sulphate in the water, but if a heavy white precipitate is formed the water contains a large amount of sulphate. Having found acid, alkali or heavy sulphate in the water it will be necessary to have this water analyzed by a chemist. It will then be apparent whether or not extra precautions are required and you will be in a position to prevent failures.



Concrete Chimneys for the Tallapiedia Power Station

Reinforced Concrete Chimneys in Havana

A very large chimney installation has recently been completed by the Weber Chimney Co., Chicago, at Havana, Cuba, for the Havana Electric Ry., Light & Power Co., consisting of four chimneys, each 275′ high and 14′ wide diam. at the top, giving a total capacity to the plant of 37,500 boiler h. p. These chimneys may be seen at a distance of 18 mi. at sea when one is approaching the City of Havana.

DESIGN FEATURES

It will be noted from the accompanying illustration that the first chimney, in the background, 200′ high, 10′ in diam. is of the cylindrical type. It was erected in 1910. It has a uniform diameter throughout its height, while the new improved type of chimneys is tapered, having the diameter decrease with the height. The shell thickness also decreases proportionately to the height, thus giving much lower stresses throughout the structure.

Calculations. — The calculations used in the design of these chimneys were based on the formulas of Turneaure & Maurer, as published in their *Principles of Reinforced Concrete,* 1910 Edition.

Storage Rooms.—In order to overcome the objectionable features of space occupied, it was decided to place a floor in the lower part of the chimney for storage. This was also done on the second floor, thus giving two complete storage rooms at each floor level, the boilers being on the second floor level. The smoke opening into the chimney is 50′ above the grade, grade being at the top of the foundation. The upper storage room in the chimney has a ceiling, which answers the purpose of the bottom of the chimney and prevents soot and smoke from coming down into the upper storage space. In each chimney there are two openings which are spaced opposite and each opening is protected by a baffle wall in the center of each chimney from any downdraft that might occur.

Lightning Protection.—The questions of lightning protection came up and it was learned that when concrete chimneys had been struck by lightning, no damage had been done, the steel seeming to act as a conductor. However, the engineers decided that they would take trolley wire and wrap the vertical members of the upper section, leaving six points standing above the top of the chimney; this was done before the concrete was poured, of course, and the chimneys had not been struck by lightning up to this time. It is hard to determine just what efficiency this copper cable has, but it is a well known fact that reinforced concrete chimneys will stand up under lightning, better than any other type of construction. The brick chimney, or brick structure of any kind, upon being struck by lightning is partially or wholly wrecked, whereas concrete, where reinforced, provides a conductor within itself to take care of any electrical charge.

Reinforcement.—The four large chimneys as illustrated rest on a reinforced concrete foundation 32′ x 32′, 6′ 6″ thick. This foundation is reinforced both parallel and diagonally to the sides, and the vertical reinforcement of the shaft consists of 200 ¾-in. round bars coming down into the foundation and anchoring beneath the horizontal steel in the foundation. The vertical steel is continuous throughout the height and takes up all the bending stresses caused by the wind-pressure. Surrounding these vertical bars are rings throughout the center height of the chimney, spaced 14″ o. c. These rings take up all the shearing stresses caused by wind and temperature.

CONSTRUCTION FEATURES

Selection of Materials.—Near Havana there may be obtained a river sand, which is a very good material for concrete purposes; however, the rock question is a serious one, as there is no rock or gravel in that locality. As the Havana Ry. Co. was re-paving a number of its tracks, an excellent material was obtained by using the old granite cobble-stones brought over from Sweden in the early days as ballast, in the schooners which were coming to Havana for sugar. These blocks were crushed by a machine brought from New York for this purpose. The sand being brought down on barges and the rock having to be crushed especially for this purpose, made the material somewhat expensive.

Miscellaneous. — The chimneys were built two at a time, a section of 4′ 6″ being built each day on each chimney. The forms were constructed of wood. The chimneys are finished at the top with a panel effect as shown in the accompanying illustration, making them very attractive in appearance.

Design Methods in Concrete Construction—Columns and Footings

By Jerome Cochran, C. E.

This is the fifth of a series of articles on Design Methods in Concrete Construction. In the first and the second article, published in this magazine, for Jan., 1915, and Feb., 1915, were given, analytically and graphically, the general principles which govern the determination of the bending moments and shears in simple beams under applied loads. The analysis of stresses in reinforced concrete rectangular beams was considered in the Mar., 1915, issue. The formulas used in designing T-beams were considered in the fourth article published in the Apr., 1915, issue, as well as the application of formulas to the design of beams and slabs. The present article will be devoted to the design of columns and footings, although it was previously announced that the next article would consider beams reinforced for compression, as well as a more detailed consideration of beam and slab designs. These subjects will be treated in a later issue.

For more intricate details of reinforced concrete design the reader is referred to such excellent treatises on design as Brook's Reinforced Concrete; *Hool's* Reinforced Concrete Construction, *Vol. I and II; Ransome & Saurbrey's* Reinforced Concrete Buildings; *Taylor & Thompson's* A Treatise on Concrete, Plain and Reinforced; *and Turneaure & Maurer's* Principles of Reinforced Concrete Construction.

COLUMNS

Concrete columns may be either plain, or reinforced with longitudinal bars only, or with bands or spirally wound metal (called *hooped* columns), or with both hoops and longitudinal bars or with structural steel shapes.

The Joint Committee recommended that reinforced columns be limited to a length of about 15 diameters, while plain concrete columns should be limited to 12 diameters, according to this Committee. Plain concrete is entirely suitable for short columns up to lengths of 6 diameters to 10 diameters, but for more slender proportions hooped or banded columns are much to be preferred.

PLAIN CONCRETE COLUMNS

The following formula for the compressive fiber stress due to eccentric loading upon solid rectangular columns of homogeneous materials may be used for columns of plain concrete (see Fig. 1), being taken from Hool's *Reinforced Concrete Construction, Vol. I. Fundamental Principles*

R = total load
A = area of column
Xo = eccentricity
t = breadth of column
fc = total unit pressure on outer fiber nearest to line of vertical pressure.

Then

$$fc = \frac{R}{A}\left(1 + \frac{6Xo}{t}\right)$$

and the additional intensity of compressive stress due to eccentric loading is seen to be equal to $\frac{R}{A} \times \frac{6Xo}{t}$

COLUMNS WITH LONGITUDINAL REINFORCEMENT

Since the modulus of elasticity of a material is the ratio of stress to deformation, it follows that for equal deformations the stresses in the steel and concrete of a concrete column will be as their moduli of elasticity. Thus,

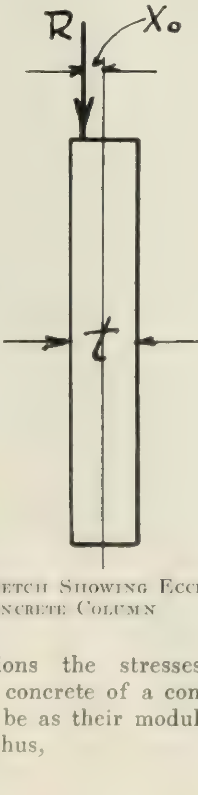


Fig. 1—Sketch Showing Eccentrically Loaded Concrete Column

$$\frac{fs}{fc} = \frac{Es}{Ec}, \text{ or } fs = fc\ n$$

Let

A = total cross-section of column
Ac = cross-section of concrete
As = cross-section of steel
p = steel ratio = $\frac{As}{A}$
fc = stress in concrete
fs = stress in steel
$n = \frac{Es}{Ec}$
P' = total strength of a plain column for the stress fc
P = total strength of a reinforced column for the stress fc.

Then,

$$P' = fc\ A$$

or $P = fc\ Ac + fs\ As = fc\ (A - pA) + fc\ np\ A$

Thus,

$$P = fc\ A\ [1 + (n-1)\ p] \qquad (1)$$

from which also

$$\frac{P}{P'} = 1 + (n-1)p \qquad (2)$$

The relative increase in strength caused by the reinforcement is

$$\frac{P-P'}{P'} = (n-1)\ p \qquad (3)$$

Example:—The effective area of a column is 144 sq. in.; load to be carried is 75,000 lbs.; and working stress on the concrete is 450 lbs. per sq. in. What percentage of longitudinal bars without hooping (but with wire stays about 12″ centers) will be required, taking n as 15?

The safe strength of a plain concrete column would be

$$144 \times 450 = 64{,}800 \text{ lbs.}$$

Hence, from equation (2),

$$\frac{P}{P'} = \frac{75}{64.8} = 1 + (15-1)p$$

$$p = 1.2 \text{ per cent.}$$

COLUMNS WITH HOOPED AND LONGITUDINAL REINFORCEMENT

These columns have the vertical reinforcement combined with spiral hooping. Tests show that about 1% of a closely spaced spiral of high carbon steel is sufficient to prevent the longitudinal bars from bulging outward and will provide a satisfactory amount of toughness with a corresponding raising of the ultimate strength beyond the elastic limit.

Example:—What sectional area of vertical steel will be required for a round column limited to 32 in. diameter, which has to bear 640,000 lbs.; with a working stress of 650 lbs. per sq. in. on the concrete and 9,750 lbs. per sq. in. on the steel, with 1% of bands or spirals, as recommended by the Joint Committee?

One and one-half inch will be considered a sufficient protective covering for the hooped reinforcement. Taking the area with the hooping as effective, the safe strength of a corresponding plain concrete column would be

$$\frac{3.1416d^2}{4}(650) = \frac{3.1416(29)^2}{4}(650) = 429{,}000$$

Hence, from equation (2)

$$\frac{P}{P'} = \frac{640}{429} = 1 + (15-1)\,p$$

P = 3.5 per cent.

WALL FOOTING

Assuming the load to be 65,000 lbs. per lin. ft. of wall and the allowable bearing on the soil 5,000 lbs. per sq. ft., the width of footing will be 65,000 ÷ 5,000 = 13′. The thickness of the wall is 2′ (see Fig. 2). The footing will be designed at three sections, at *a*, 4½′ from the center of the wall, at *b*, 3′ from the center, and at *c*, 1′ from the center. Taking a 1-ft. length of footing the vertical shears and bending moments will be as follows.

$Va = 5{,}000 \times 2 = 10{,}000$ lbs.

$Vb = 5{,}000 \times 3\tfrac{1}{2} = 17{,}500$ lbs.

$Vc = 5{,}000 \times 5\tfrac{1}{2} = 27{,}500$ lbs.

$$Ma = \frac{5{,}000 \times 2^2 \times 12}{2} = 120{,}000 \text{ lbs. ins.}$$

$$Mb = \frac{5{,}000 \times 3.5^2 \times 12}{2} = 367{,}500 \text{ lbs. ins.}$$

$$Mc = \frac{5{,}000 \times 5.5^2 \times 12}{2} = 907{,}500 \text{ lbs. ins.}$$

The concrete will be assumed to have an allowable compressive unit-stress of $fc = 650$ lbs. per sq. in. and the steel to have an allowable tensile unit-stress of $fs = 16{,}000$ lbs. per sq. in. The ratio of the modulus of elasticity of steel to that of concrete will be assumed as $n = 15$. The depth to center of reinforcing steel necessary to give a compressive stress in the concrete of 650 lbs. per sq. in. is given by the formula, $d =$ the square root of $M \div Rb$, in which $R = fc\,kj \div 2$. In the latter formula $k =$ the square root of $2\,pn + (pn)^2$ minus pn and

$$j = \frac{1-k}{3};\ p = \frac{2}{\frac{fs}{fc}\left(\frac{fs}{nfc} + 1\right)}$$

The work involved in getting the value of *R* will be greatly reduced by using the diagrams found in Turneaure & Maurer's *Principles of Reinforced Concrete Construction.* For the problem at hand the value of *R* is 106.

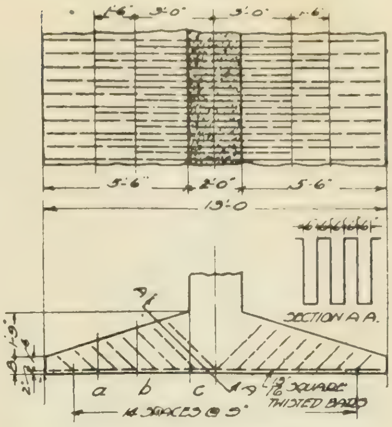


FIG. 2—REINFORCED CONCRETE WALL FOOTING

Solving for *d*, we have $da =$ the square root of $120{,}000 \div (106 \times 12) = 9.7$ ins.; $db = 17.0$ ins.; and $dc = 26.7$ ins. (27 ins. being adopted).

As it is inadvisable to use a depth at any section less than about 6″ the form shown in Fig. 2 will be adopted. The steel in the bottom will be given a 2-in. insulation.

The area of steel required at each section is given by the formula,

$$As = \frac{M}{fs\,jd}$$

Using the values of *d* obtained above, so that the footing may be equally strong in tension and in compression:

$Aa = 120{,}000/\ (16{,}000 \times 0.86 \times 9.7) = 0.89$ sq. in.

$Ab = 367{,}500/\ (16{,}000 \times 0.86 \times 17.0) = 1.57$ sq. in.

$Ac = 907{,}500/\ (16{,}000 \times 0.86 \times 26.7) = 2.48$ sq. ins.

Using a bar spacing of 3″ c. to c. there will be 4 bars in 1′ of length of the footing. The required area of each bar will be 2.48 ÷ 4 = 0.62 sq. in. A 13/16-in. sq. twisted bar, giving an area of 0.66 sq. in., will be adopted, although 1⅛-in. sq. bars spaced 6″ centers would also answer. Three 13/16-in. sq. twisted bars will furnish the required area at *b*, while two bars furnish that required at *a;* hence certain of the bars may be bent up or cut off as shown in Fig. 2.

Using an allowable bond unit-stress of 140 lbs. per sq. in. of bar surface the necessary length of bar to develop full strength is $(16{,}000 \times 0.66)/(140 \times 3.25) = 23.2$ ins. Computing the bond stress in the bars by the formula

$$u = \frac{Sd - M \tan \alpha}{jd^2\,\Sigma o}$$

in which tan α is the slope of the upper surface of the footing and Σo the perimeter of the bars at the section in question, the values are as follows:

$$ua = \frac{10{,}000 \times 13.64 - 120{,}000}{0.86 \times 13.64^2 \times 6.50 \times 0.318} = 94 \text{ lbs. per sq. in.}$$

$$ub = \frac{17{,}500 \times 19.36 - 367{,}500}{0.86 \times 19.36^2 \times 9.75 \times 0.318} = 71 \text{ lbs. per sq. in.}$$

$$uc = \frac{27{,}500 \times 26.7 - 907{,}500}{0.86 \times 26.7^2 \times 13 \times 0.318} = 56 \text{ lbs. per sq. in.}$$

All of these values are well below the safe limit of 140 lbs. per sq. in.

Assuming that the concrete takes no longitudinal tension the maximum intensity of diagonal tension is given by the formula

$$t = \frac{Sd - M \tan \alpha}{jd^2}$$

The maximum diagonal tension may also be computed by taking the bond stress values and multiplying them by the perimeter of the bars, resulting in a shorter method than using the above formula.

Thus,

$ta = (94 \times 6.50) \div 12 = 51$ lbs. per sq. in.

$tb = (71 \times 9.75) \div 12 = 58$ lbs. per sq. in.

$tc = (56 \times 13) \div 12 = 60$ lbs. per sq. in.

As the diagonal tension exceeds 40 lbs. per sq. in., which is allowed by conservative specifications, stirrups will be designed to carry all of this tension. Placing the stirrups on a 45-deg. slope and using ⅜-in. square twisted bars with two prongs in a 12-in. length, as shown in Fig. 2, the strength of one line of stirrups in a 12-in. length will be $16{,}000 \times (3/8)^2 \times 2 = 4{,}500$ lbs. The horizontal distance between rows of stirrups may be found by the formula

$$S = \frac{4{,}500}{12 \times t \times \cos 45°}$$

giving

$Sa = 4{,}500/12 \times 51 \times 0.707 = 10$ inches

$Sb = 4{,}500/12 \times 58 \times 0.707 = 9$ inches

$Sc = 4{,}500/12 \times 60 \times 0.707 = 8$ inches

A uniform spacing of 9″ will be adopted.

The maximum intensity of vertical

shears occurs at the top of the footing and equals $f_c \tan \alpha$, where α is the inclination of the upper surface of the slab. The shearing stress is therefore $650 \times 0.318 = 206$ *lbs. per sq. in.*

COLUMN FOOTINGS

A concrete footing with two-way reinforcement as shown in Fig. 3 is not as susceptible of a rational analysis as that with four-way reinforcement. The stresses in either type may be approximately analyzed by either flat-slab or beam formulas. The design of a footing based on the flat-slab principle is given on p. 644 of the second edition of Taylor & Thompson's *Concrete, Plain and Reinforced.* Very tedious computations are involved with the formulas based on the theory of the flat plate, which are only approximations.

It is usually assumed that the section of maximum bending moment and shear is at the outer face of the column when using beam formulas. With the two-way reinforced footing the stress cannot be uniformly distributed over this section. Referring to Fig. 3, the load from the soil at point *t* will go to the column through *ut* acting as a cantilever beam, while part of the load at *r* will first go to some point as *t* through *rt* acting as a beam, and the balance to some point as *s* through *rs* acting as a beam. The part which goes to *t* will then go to *u* through *tu* acting as a beam, while the part which goes to *s* will go to *v* through *sv* acting as a beam. The stress along the plane X-X will vary from a minimum near the sides of the footing to a maximum at the column face.

Prof. A. N. Talbot, in *Bulletin* No. 67, Engrg. Exp. Sta., Univ. of Ill., summarizes the proper method of designing reinforced concrete column footings as follows:

> For footings having projections of ordinary dimensions, the critical section for the bending moment for one direction (which in two-way reinforced concrete footings is to be resisted by one set of bars) may be taken to be at a vertical section passing through the face of the pier. In calculating this moment, all the upward load on the rectangle lying between a face of the pier and the edge of the footing is considered to act at a center of pressure located at a point half way out from the pier, and half of the upward load on the two corner squares is considered to act at a center of pressure located at a point six-tenths of the width of the projection from the given section. * * * * *
>
> With two-way reinforcement evenly spaced over the footing, it seems that the tensile stress is approximately the same in bars lying within a space somewhat greater than the width of the pier and that there is also considerable stress in the bars which lie near the edges of the footing. In intermediate bars stresses intermediate in amount will be developed.

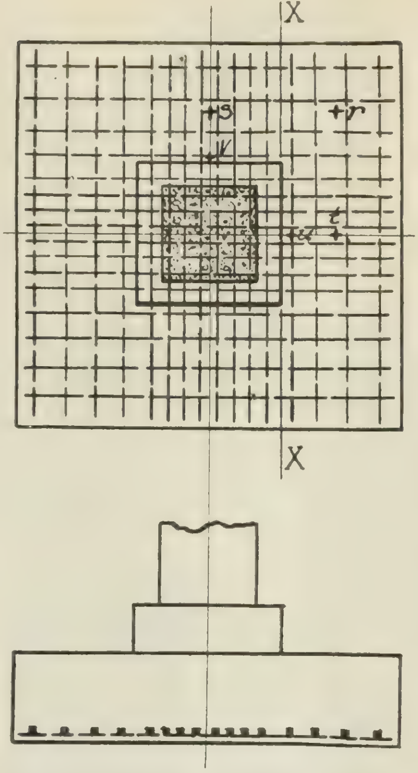


Fig. 3—Reinforced Concrete Column Footing

> In footings having two-way reinforcement spaced uniformly over the footing, the method proposed, for determining the maximum tensile stress in the reinforcing bars, is to use in the calculation of resisting moment at a section at the face of the pier the area of all the bars which lie within a width of footing equal to the width of pier plus twice the thickness of footing, plus half the remaining distance on each side to the edge of the footing. This method gives results in keeping with the results of tests. When the spacing through the middle of the width of the footing is closer, or even when the bars are concentrated in the middle portion, the same method may be applied without serious error. Enough reinforcement should be placed in the outer portion to prevent the concentration of tension cracks in the concrete and to provide for other distribution stresses.
>
> The method proposed for calculating maximum bond stress in column footings having two-way reinforcement evenly spaced as noted in the preceding paragraph, is to use the ordinary bond-stress formula, and to consider the circumferences of all the bars which were used in the calculation of tensile stress, and to take for the external shear that amount of upward pressure or load which was used in the calculation of the bending moment at the given section.

In the preceding discussion the slab is assumed to have a horizontal upper surface.

FOUR-WAY REINFORCED FOOTING

On pp. 479-81 of Jacoby and Davis' *Foundations of Bridges and Buildings,* the design of a four-way reinforced concrete footing is worked out in complete order. This type of footing is more susceptible of a rational analysis than the two-way reinforced footing and tests made at the Univ. of Ill. by Prof. A. N. Talbot show that this type gives a somewhat stronger footing than the two-way type.

COMBINED REINFORCED FOOTING

Where one footing serves for two columns, the method of obtaining the shape of footing, as well as the shears and bending moments, is similar to that for the I-beam grillage designed on pp. 464-8 of Jacoby & Davis' *Foundations of Bridges and Buildings,* to which the reader is referred, as well as to an example of this type of footing worked out on p. 647 of the second edition of Taylor & Thompson's *Concrete, Plain and Reinforced.*

Waterproofing and Dampproofing in Egypt

There is a considerable amount of waterproofing and dampproofing material used in Egypt, according to *Commerce Reports.* Most of the houses here have flat roofs, asphalt being generally employed by local contractors for roofing purposes. Of late asphalted felt and bituminous sheeting protected by plaster have come into use and are giving satisfaction, as they afford ample protection from the violent sun and occasional but torrential rains. Rain falls but a few times a year in Egypt, but when it does it is exceptionally heavy. Alexandria has a slightly heavier rainfall annually than any other city in Egypt.

The use of paints on the outside of stucco and concrete for dampproofing purposes is not customary. It has been found, however,, that where local bricks have been used in the construction of houses they have not proved durable, and occasionally a coating of English manufacture, called "Szerelmy," has been applied with some success. Stucco and concrete walls do not crack if the work has been well done.

American firms have attempted on several occasions to introduce their dampproofings and waterproofings in Egypt and some sales have resulted. There are two concerns, both in Cairo, controlled by British capital, that have a practical monopoly on all the dampproofing and waterproofing sold in Egypt. Figures of importation of proofings are not available, felting and roofing not being specified in the customs statistics.

The central mill of the Giant Portland Cement Co., at Egypt, Pa., has resumed operations. The Reliance mill of the same company is closed for a short time to make repairs.

Field Methods in Concrete Construction—Beam and Slab Forms

By Jerome Cochran, C. E.[1]

The series of articles on field methods in concrete construction, of which this is the fifth, has been planned in opposition to the general assumption on the part of writers that standards or methods of construction have been established long ago and have become common knowledge. The first articles on "Selection of Concrete Materials" appeared in this magazine for Jan., 1915; the second article on "Proportioning and Mixing Concrete" appeared in Feb., 1915; the third article on "Design and Construction of Forms in General" appeared in Mar., 1915, and the fourth article on "Column Forms" appeared in Apr., 1915.

The following article relates to the fabrication and the erection of beam and slab forms.

INTRODUCTION

Slab and girder construction for floors and roofs is of four kinds: (1) Concrete slab and steel beam construction in place; (2) concrete slab and girder construction in place; (3) concrete joist and hollow tile construction in place (resting on concrete or steel beam); and (4) separately molded slab and beam construction. The fourth method of construction is distinct from the others in respect to form work as well as other details, and will not be considered in this article.

A rough and very expensive method of constructing floor forms consists in putting them together box-fashion, nailing all the joints securely. Such forms cannot be removed without breaking the lumber to pieces and destroying a great deal of the concrete, particularly the corners.

An improvement over this method consists in making the slab-panel forms each in one piece as discussed elsewhere in this article, resting upon the form-panels for the beam-sides. Fig. 1 shows schematically the most essential parts of this arrangement, of which there is a very large number of variations. Usually, however, the parts are so arranged that the beam-bottom with the shores under same can be left in place while the panels are being removed, for the purpose of keeping the beams supported for a longer period than the slab.

Such an arrangement insures the safety of the structure, for while the concrete may have been assumed as having sufficient strength for the slabs to carry their own weight, it is advisable to leave the shores under the beams or girders for a period of a week longer, at least, entirely to avoid any danger of a collapse. This also at the same time releases the greater part of the form work for use again. It is of advantage also to lay bare the concrete as soon as possible to the hardening action of the free air. The slabs may be similarly supported by shores wedged up against plank caps; no very great amount of lumber is required for this staging and it gives a large assurance of safety.

An improved method of centering is shown in Fig. 23, where the long box is split centrally down the middle, each half being held together by the triangular cleats, while the two halves are hinged together. The beam bottoms rest upon cleats along the lower edge of the box, and these cleats also strengthen the bottoms of the boxes where they rest upon the supporting benches or horses. Removable heads are used to close the boxes at each end. In removing the forms, the horses are first taken down, then the removable heads are taken off, and finally, the boxes are collapsed and removed.

Several objections to the common method of constructing beam and slab forms are overcome in this arrangement, i. e., the forms themselves can be taken down, again put together, and erected by ordinary labor, there being no cutting or adjustment of any kind. Falsework of the ordinary kind is soon destroyed by the continuous prying and pounding required to get it loose from the concrete, and the jarring and knocking about while shifting from floor to floor. The horses used for supporting the boxes in the latter type form at once a safe and even foundation for the form work.

A suggested scheme for slab and beam forms is given in Godfrey's *Concrete*, p. 116, as follows:

> Use a heavy plank under the girder 4" wider than the girder. On top of this nail a 1-in. planed board, the width of the girder, along the middle of the plank. There will be a 2-in. margin on each side. One in. of this will be taken up with the side boards for the girder. The other inch will be used as a ledge to support the joists for the slab which can be blocked up by nailing them to the vertical studding for the sides of the girder. If strips be nailed lightly to these joists and studding, and if the sheathing for slabs and girders be nailed together with cleats to form units, there will need to be but little nailing into the wood in contact with the concrete. The heavy plank under the girder should be supported by props from 3′ to 6′ apart. For heavy girders it may be stiffened by knee braces to the props or by a pair of joists nailed to the side of the props.

FABRICATION OF BEAM AND GIRDER BOXES OR FORMS

A very common method of fabricating beam and girder forms is to use inverted boxes with the sides made with a draw, consisting of two planks or whatever number is required to make the depth, battened or cleated together so that each side can be handled as one piece. For beams 12″ or less in depth, it is usually customary to use a single board on the side, but for beams or girders 16″ or 18″ in depth, two or more boards running lengthwise of the construction are employed. Cleats cut to proper length are nailed on before the sides of the forms are put in place, and act as a support for the joists which in turn support form boards of the slab, as shown in the accompanying illustrations. Strips may also be nailed along the cleats or battens to support the joists. Cleats are usually spaced from 18″ to 24″ on centers on beams and girders, sometimes every other one projecting about 4″ below bottoms to nail on cross-piece.

For sides of beams or girders, either 1-in. or 1½-in. lumber is sufficient; usually a cheap grade of wood is used, such as sap pine. The bottoms of beams and girders should be of 2-in. stuff, although 1½-in. stuff is often used.

REINFORCING FORM INTERSECTIONS

Where the beam forms intersect with the girder forms or the beam and girder forms with column forms the sides of the forms of the girders and columns are cut out as illustrated in the last article published in Concrete-Cement Age, for Apr., 1915, and this cut-out is reinforced with cleats on the side and on the bottom, to act as stiffeners and to support the beam or girder form. When the floor slabs and their supporting girders are built monolithic, a 2-in. x 4-in. strip is very often nailed along the outside of the beam forms to carry the flooring for the slabs.

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[1] Cons. Engr., Houston, Tex.

SPLAYING SIDES OF BOXES

In order that beam and girder forms may be readily removed, the sides should be splayed slightly. Otherwise the concrete is very likely to adhere to the forms so as to make the task of removing them as a unit almost an impossibility.

FASTENING SIDES OF BOXES

The sides of the boxes should project down past the edges of the bottom of the beam and girder forms, and they should be held tightly together by wedges, clamps or stiff braces as shown, to prevent the pressure of the concrete from springing them away from the bottom boards. Wrought iron clamps are frequently used in place of extra nailing on the bottom edges of beam and girder forms as shown in Fig. 9.

BRACING SIDES OF BOXES

It is essential that the sides of the boxes, especially with deep beams and girders, be true and rigid, and sufficiently braced to withstand the lateral pressure of the concrete and not bulge or warp. While badly twisted and sagged forms may not produce an unsafe building, yet it is usually a criterion of the remainder of the construction and there is no excuse for such work.

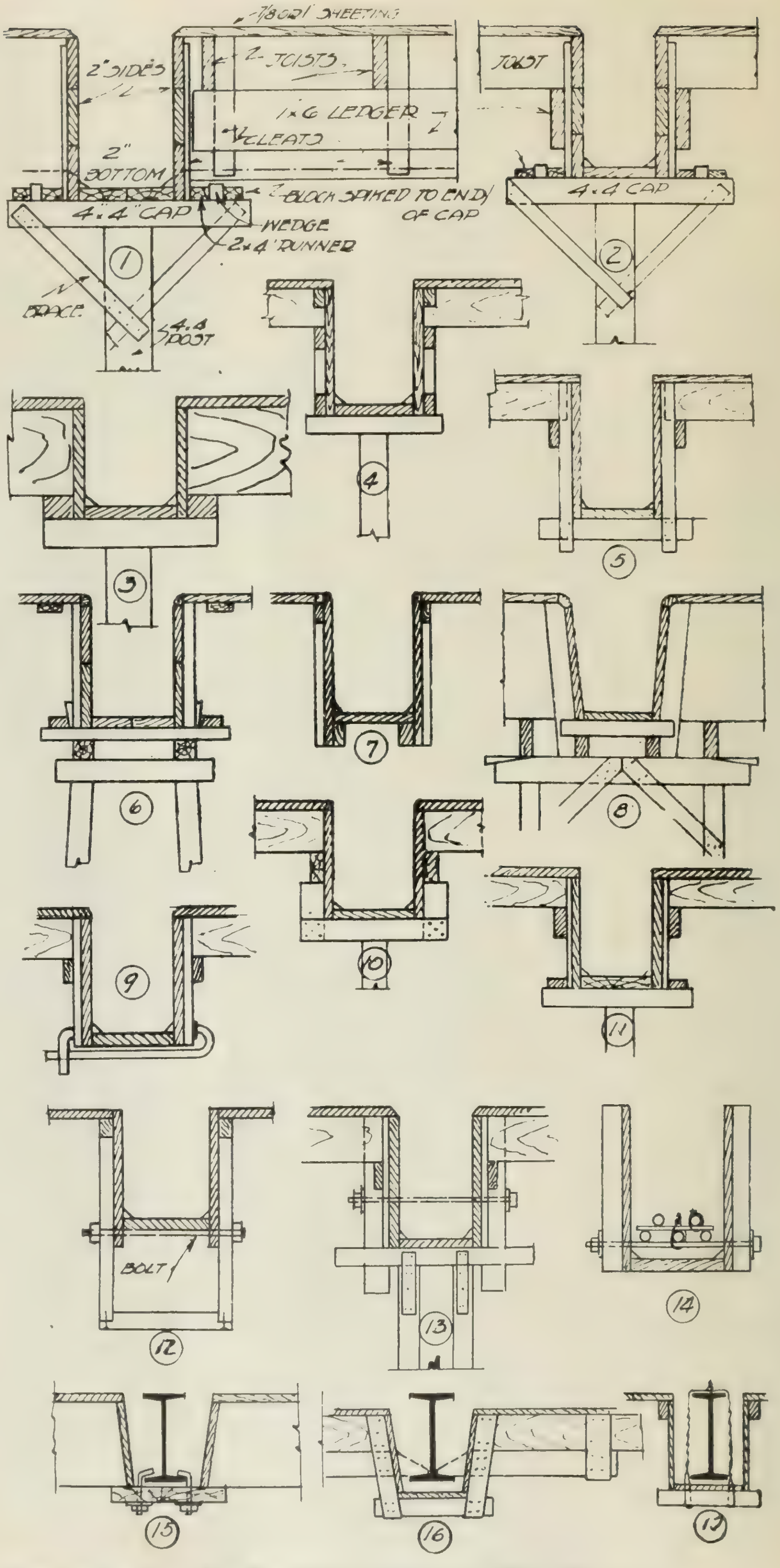
BEVELED STRIPS

Diagonal, bevel or triangular strips should be tacked along the corners of all beam and girder forms as a fillet to cut off the corner by a plane making equal angles with the adjacent faces.

Chamfers should occur also in the ceiling angles, in order to prevent spalling off of the corners when removing forms. The usual custom of using small crow-bars to force the forms off the concrete is likely to break off corners unless chamfers are used.

OPENINGS IN GIRDER BOXES

Girder boxes should generally be provided with a pocket or loose handhole cap in order to permit cleaning out chips, shavings, etc., after the columns are poured. The removable cap should be tacked to the side of the box so that it will be ready to put back in place after the girder is cleaned out and before the concrete is poured. It is the care exercised in just such points that results in securing work which is first-class in every respect, for it must be remembered that concrete once cast cannot be repaired without taking out an entire member or section of a floor, so that it becomes a very serious matter. Attention to details will obviate the necessity for such a procedure.



Figs. 1 to 17—Forms for Reinforced Concrete and Steel Beams

CAMBER OF CONCRETE FORMS

Beam and girder forms should be given a slight camber or crown in order to allow for setting of the falsework. This may be done by assuming a deflection of the forms and of the finished concrete beam or girder equal to about 3/8" for every 10' of span. The bottoms of the boxes should taper off uniformly to each end, and they should be rigidly to this line.

The object of cambering beam and girder forms is to prevent the appearance of sag, even though the bottom may be perfectly level and so held during the placing of the concrete. There is generally a slight movement in beam and girder forms due to the adjustment of the wedges under the shores and the compressing of the lumber, so that it is advisable to raise the bottoms of the forms slightly higher in the center than at the ends.

ERECTION OF BEAM AND GIRDER FORMS

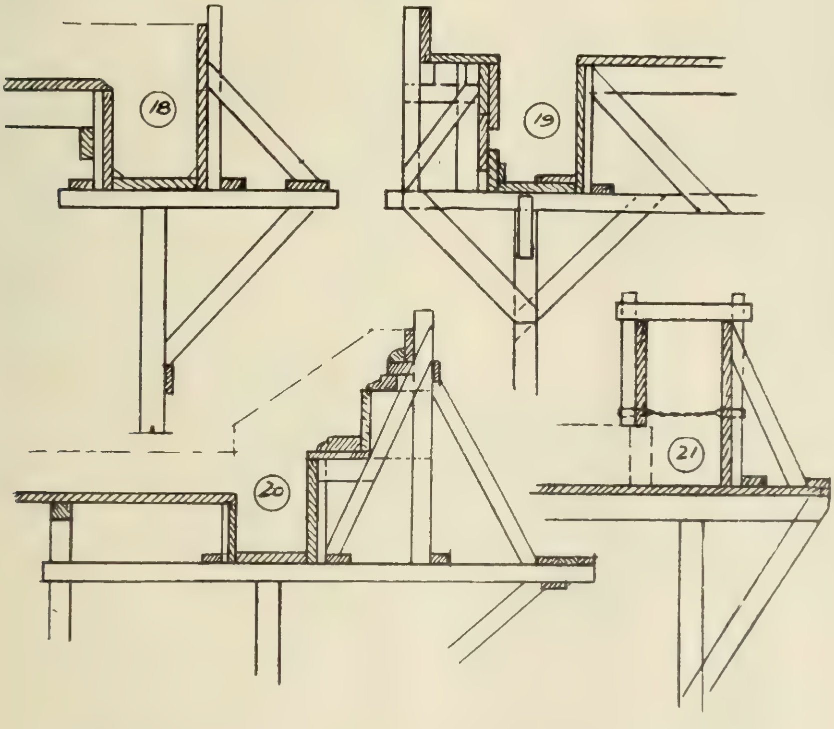
Care must be taken to see that the joints at the intersections of beam or girder boxes with girders or columns are especially tight, in order that there be no leakage of the concrete at or near the ends of beam or girder spans, as the shearing stress is greatest at the ends of spans. This precaution regarding water-tight joints at intersections as well as in the boxes themselves applies to all beam and girder forms for wet concrete, which is the kind generally used for reinforced concrete floor construction. Otherwise the leakage of the liquid mass will leave the concrete porous or honeycombed.

Cracks or joints in beam or girder boxes may be closed by putty or clay, plaster of Paris, oakum, cotton, or strips of wood. The use of fire clay to close knot-holes, etc., is also recommended.

Where steel beams act as girders for the support of concrete beams, long bolts or rods may be hung over the steel beams and extend below the bottom flange sufficiently far to permit of a heavy stringer running parallel to the steel beams to be secured thereto, and to act as a secondary beam or support for the forms of the concrete beams. Whatever method is employed, all parts should be figured strong enough to carry loads coming upon them, the same as if they formed a permanent construction.

FABRICATION OF STEEL FORMS

Slab forms or panels are usually put up in sections and cleated or battened together. These battened form boards are often used in the construction of several floors, the reinforced concrete work being designed with this object in view, that is, the panels between the beams are made a uniform size. They are generally made in units of two or four pieces to a panel, although more units may be used where panels are large enough to warrant them. The units should not be too large or they cannot be readily handled without taking apart. Several types of slab panels are shown in Figs. 23, 24, 25, 26 and 27. These are self-explanatory.



Figs. 18 to 21—Forms for Reinforced Concrete Spandrel Beams

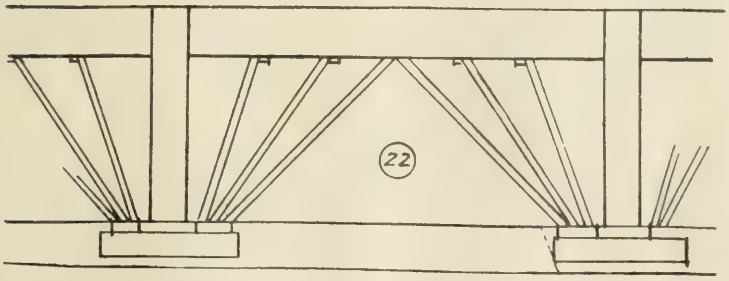


Fig. 22—Diagonal Shoring of Beam Boxes

Sufficient bracing must be used to prevent slab forms from sagging. The joints should not be spaced more than 2′ apart for 1-in. form boards. They are usually supported on 2-in. x 4-in. or 2-in. x 6-in. strips fastened to the sides of the beam forms, or they may be independently supported. A line or two of supports should be placed under the joints. Where a single line of supports is used, it should be placed down the center line of the panel. Wedges are usually provided under the joists where they abut on beam forms, the wedges being properly keyed in place. No splice joints should be allowed at any point.

The lagging of slabs should be 1½-in. stuff, but it can be as light as 1-in. if the boards are narrow, say not over 6″ wide, and tongued and grooved together. Light 1-in. stuff, of soft wood, is likely to be pretty well worn out before the top of an eight-story or 10-story building is reached, and the under surface of the concrete will show the wear badly. Lumber planed on the side next to the concrete permits easier removal and should be used where possible. The form boards for slab construction are very often made of tongue-and-grooved material of 4/4 or 5/4 dressed yellow pine flooring surfaced on one side.

Joists may be of 3-in. x 4-in. or 2-in. x 6-in. stuff. Sometimes 2-in. x 4-in. or 2-in. x 8-in. stuff is used, depending upon the span, spacing and weight of slab.

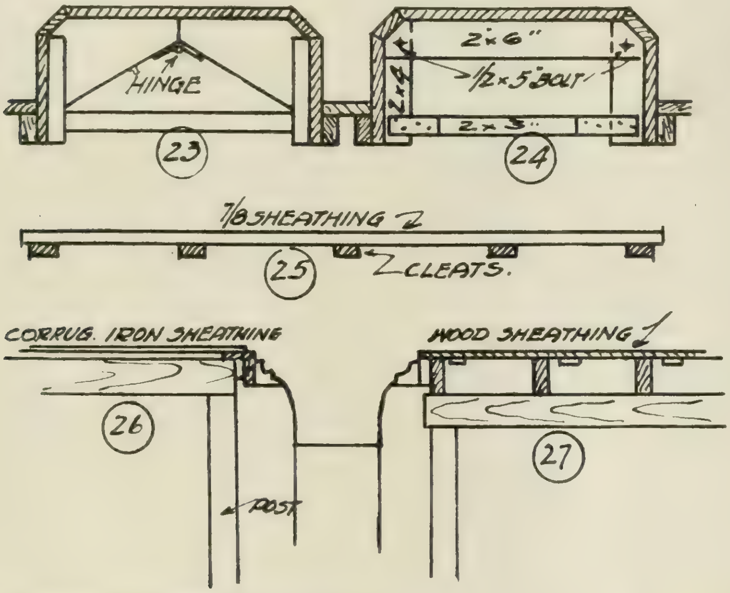
CENTERING FOR HOLLOW TILE FLOORS

The construction of forms for hollow-tile and joint floors is a very simple matter, as there is very little boxing. The centering usually consists of planks, a little wider than the 4-in. or 5-in. reinforced concrete beams, set where the beams are to come above. The edges of the tiles rest on the planks, and the tiles from the sides of the concrete beam molds, a 1-in. to 3-in. slab being laid on top, connecting the beams laterally. The floor lagging is supported by means of shores or props, so spaced and braced as to give proper stiffness to the centering.

CENTERING FOR FLOOR SLABS BETWEEN STEEL BEAMS

The centers for slabs and arches used as a floor filling between steel beams usually consist of flat or curved lagging carried on straight or arched joists suspended from the steel beams or girders. The joists and lagging may be framed together into panels of convenient size for carrying and erecting. When the floor slab rests upon the top flanges of the beams the lagging joists may rest upon the bottom flange of the beams. A more complex centering is required where the slab has to be haunched around the I-beam. When the filling slab consists of either a flat floor plate or a floor arch and rests upon the bottom flange of the beams the lagging is sometimes hung from the bottom flanges by hook-bolts.

The lagging is sometimes supported by wire ties attached to the steel beams through holes punched in the top flanges, the ties passing around and supporting the scantling, which in turn supports the lagging. In order to avoid possible injury to the slab forms, the holes should be bored at least 1/8" larger than the diameter of the wire which passes through them.



FIGS. 23 TO 27—VARIOUS TYPES OF SLAB FORMS

SUPPORT OF FLOOR FORMS

Beam and slab forms are usually supported at the ends by wall and column forms and at intermediate points by shores (sometimes called posts, props, shoring, staging, studding, studs, supports, uprights or vertical pieces) resting upon the floor below, as shown in the accompanying illustrations. The shores usually rest on double wedges on the floor and bear with their upper ends against the bottom of the beam and girder forms; that is, they should bear against a cap piece and on a sill to distribute the load.

The supports of floor forms should be sufficiently strong to carry the dead load of the wet concrete and they should be wedged up tight at bottom and top, but not so tight as to require hard driving, which is sure to injure the setting concrete under them.

While it is usually customary to support beam and girder forms by shores, sometimes to save material, and at the same time in order to brace the studing, only two shores are used and the intermediate supports are obtained by cutting in oblique braces on each side of the upright. The vertical piece is generally made of about a 4-in. x 6-in. piece, while 4-in. x 4-in. or 2-in. x 6-in. pieces are used for the braces, the braces being cut to the proper bevel to fit the under side of the bottom form board, and at the lower end to fit against the vertical. The braces are usually wedged to the vertical against a cleat or batten and nailed in order to prevent any possibility of their slipping. This method of stud centering stiffens the story construction laterally and prevents any dangerous vibration or swaying of shoring somewhat similar to that just described is shown in Fig. 22.

BRACING OF FLOOR FORMS

An adequately stiff or rigid sway-bracing should be provided for the centering, the several shores being connected by nailing diagonal and horizontal boards to the shores, thereby lining and bracing them with a stable falsework. The shores should be stayed along the line of the joist at the top and longitudinally and transversely about midway for stories not exceeding 12′ in height. Bracing is frequently done carelessly, and must be watched, particularly in regard to its sufficiency to preserve accurate alignment. All studding must be well cross-braced, especially in the upper stories, to resist wind pressure. Little attention is usually paid to the effect of wind on exposed structures, as a rule, but with works carried on in exposed localities subjected to considerable pressure, at times it is a menace that is well guarded against by providing sufficient diagonal bracing between the columns and the shores as well as between the beams.

LOCATION AND SPACING OF SHORES

Shores or props should come at mid-span, one-third-span, quarter-span, or at such frequent intervals that no material deflection can exist between supports in the beam and girder forms. No general rule for the spacing of shores is applicable, except that enough lumber must be used to hold the forms rigid and true to line and level. Many unsightly pieces of work have been performed due to lack of ample shores under the forms to hold them rigid and secure while the concrete is being placed. Usually 3-in. x 4-in. or 4-in. x 4-in. pieces are set under centers of beams and girders varying from 3′ to 5′ apart, according to the spacing of the beams and weight of the concrete to be put in the forms. The maximum spacing of shores under the floor forms at centers should not as a rule exceed 4′. Too much stress cannot be placed upon the importance of having an ample number of shores under the forms, which should be regulated by the judgment of the foreman and the boss carpenter.

LENGTH OF FLOORS

Shores should be set up and do their duty without hard driving, being cut to such a length that the cap and footing pieces can be placed and the double wedges can be started and tightened. If the shores are cut too long, they have to be driven into place, with danger to the form work or to the setting concrete; if too short, excessive blocking-up is necesitated and the support is liable to be unstable.

SPLICING OF SHORES

It is frequently the practice to piece out the studding or shores by

(Continued on p. 309)

The New Delaware and Hudson Office Building, at Albany, N. Y.

By Marcus T. Reynolds

The trim of the handsome new building of the Delaware & Hudson R. R. office building, at Albany, N. Y., shown in the accompanying illustrations, is of concrete stone, while the plain wall surfaces are of seam-face granite. Marcus T. Reynolds, Albany, is the architect. The concrete stone was manufactured by the Emerson & Norris Co., Boston and New York. The attitude of the architect toward concrete stone is typical and excerpts from his own letter are of special interest.

The size of the operation for the Delaware & Hudson Co. at Albany, was such that it was necessary to reduce the expense of construction as far as possible, and it was for this reason that I looked into the question of synthetic stone as a material for this building.

I must say that at the start I had a very strong prejudice against the use of this material, but after visiting New York, Boston and Philadelphia, and seeing buildings in which the stone had been in use for many years, I became converted and decided to adopt it in the building in question.

I found a very great difference in the character of the stone furnished for the buildings which I had examined. There seemed to be about six firms engaged in the manufacture of synthetic stone, and of these only three produced stone of approximately the same character; that produced by the others resembled concrete rather than stone and had a most unsightly appearance, as the surface was discolored, and disfigured by a large number of hair-cracks.

MADE IN SAND MOLDS

I discovered that the companies producing the better class of material made use of a patented process. which covered the use of sand molds. I also learned that there was much higher skill, both in modeling and jointing the stones exhibited by these companies, than was apparent in the work of the companies furnishing stone by other processes. I therefore determined to narrow

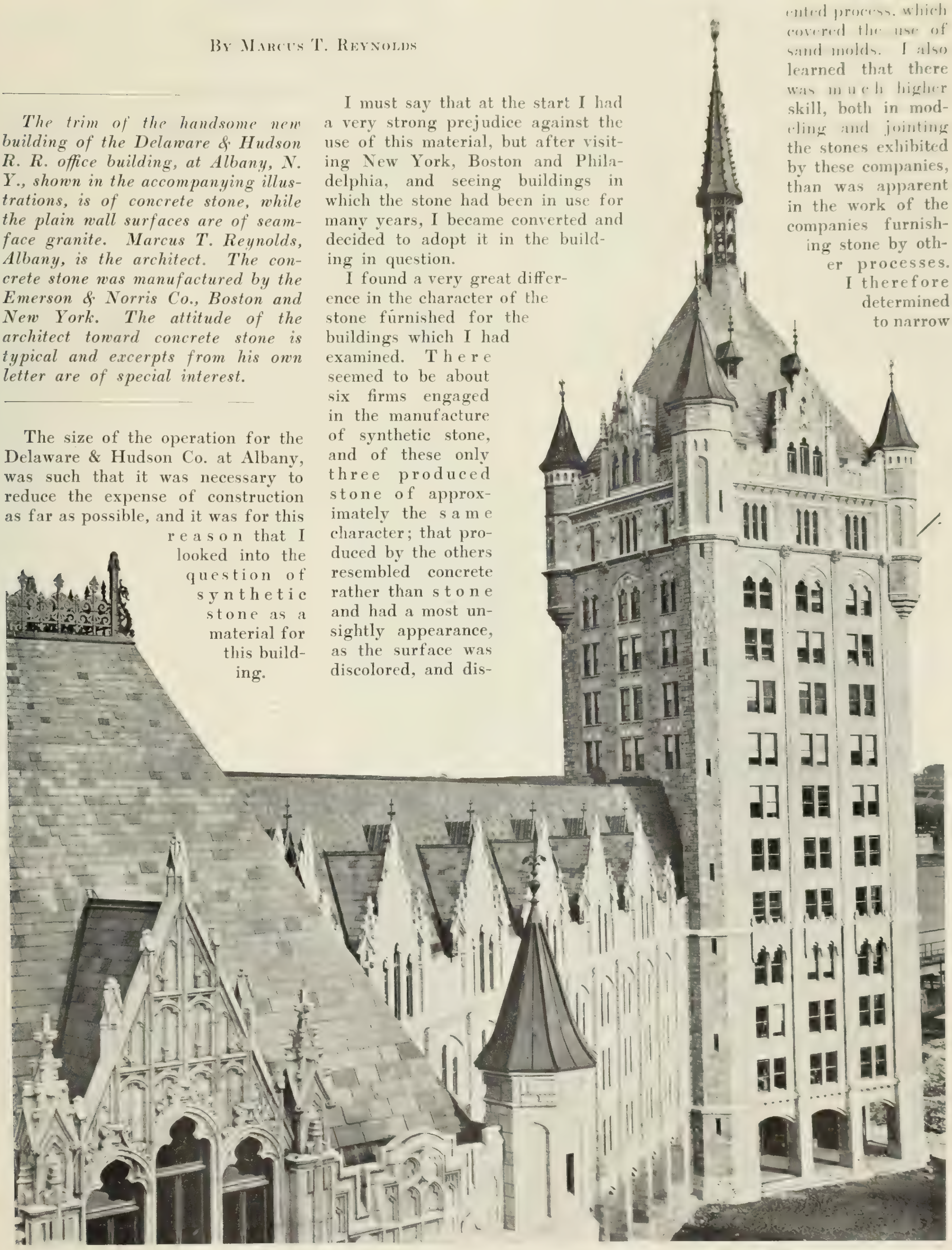


Fig. 1—New Delaware and Hudson Building, Albany—Concrete Stone Trim

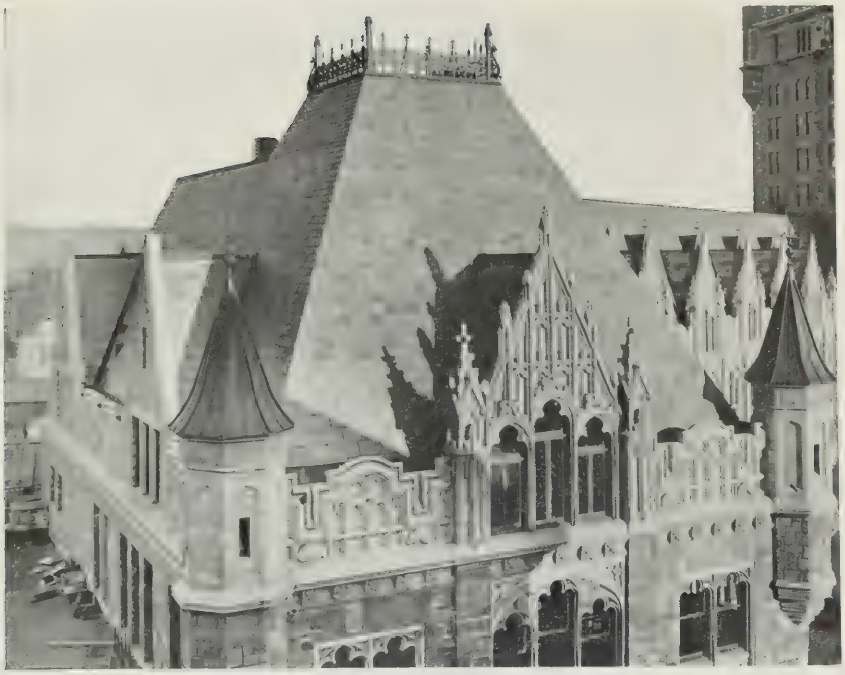


FIG. 2—DETAIL, DELAWARE AND HUDSON BUILDING

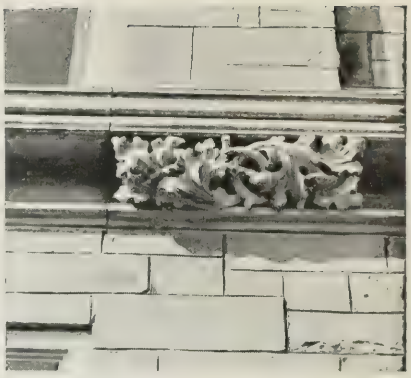


FIG. 5—DETAIL, SHOWING CARVED CONCRETE STONE

competition to three firms and to reject all other bids.

The contract was finally let at approximately $55,000 and an estimate in limestone was taken for approximately $75,000. I got this in order to show the relative costs of the two materials. The difference in the present case was greater than in an average building, as the design was such that the same patterns would answer for all of the 13 bays, of which the four-story wing was composed, and care had also been taken to permit the use of the same patterns to a very great extent in the construction of the 12-story tower.

An estimate also was received from one of the concerns which manufactured stone which frankly re-

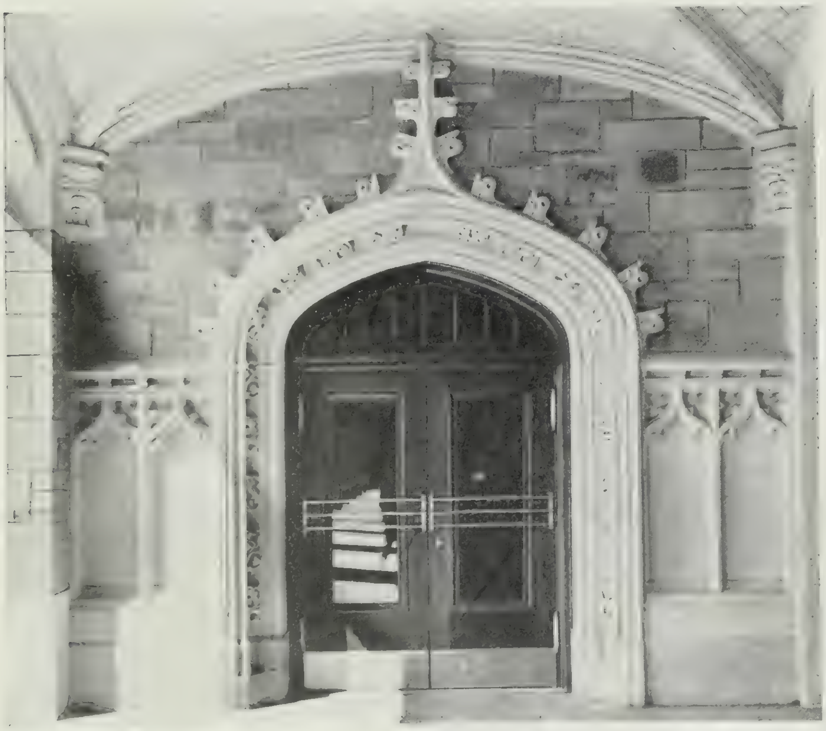


FIG. 3 ENTRANCE DETAIL

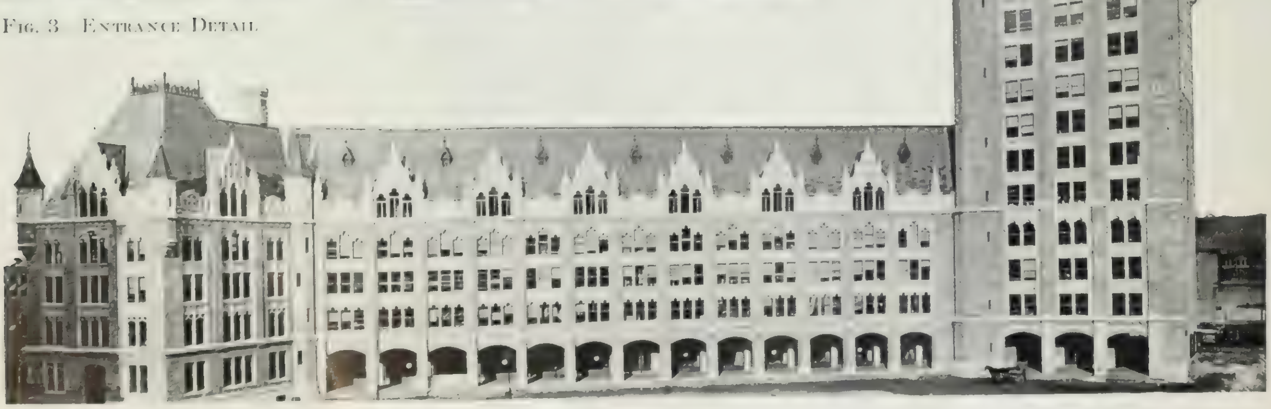


FIG. 4 GENERAL VIEW, DELAWARE AND HUDSON BUILDING

sembled concrete rather than a counterfeited stone, showing a reduction of $18,000.

The stone as furnished is of a light gray color, showing a marble aggregate which gives a sparkle to the surface that makes it very attractive, and was used as trim for the wall surfaces, which were of seam-face granite of a light silver gray.

As the building was designed in the Gothic style, a comparatively small proportion of the seam-face granite was employed, but its effective value was heightened by the elaboration of the detail of the artificial stone.

Two different kinds of synthetic stone were used: one for the water-table and steps, which imitated granite, and the balance of a lighter color approximating Indiana limestone. The specifications covering the former were as follows:

The granite (granite-concrete) is to be composed of hard, white marble, the largest piece not over ½", and of black granite, the largest piece not over ¼"; the two combined in proper proportion to give the desired effect.

All exposed surfaces are to be given a bush-hammered finish, which may be done mechanically if the contractor has the facilities.

The balance of the work is to be composed of hard white marble, no piece larger than will pass through a ½-in. ring, and shall be given a rubbed surface.

The following specifications will apply to the material used in both of the synthetic stones:

The aggregate, i. e., hard white marble, shall be mixed with Portland cement.

No sand is to be used and the aggregates are to be so proportioned as to present the least amount of voids, and mixed not over 5 parts nor less than 3½ parts by volume, to 1 part of cement. This is to be mixed with a machine mixer, dry, and enough water added to bring the mass to such a consistency as will allow it to flow easily. The mixture shall be transferred from the mixer into a bucket in which there is a continuous machine agitator. It shall then be immediately poured in a continuous stream into a sand mold, sharp and true to pattern and detail. After having been removed from the mold and having become perfectly hard, it shall be dressed in the following manner. Those specified as having a bush-hammered finish shall be so finished. The perpendicular flat surfaces shall be machine-tooled, 6 cuts to the in.; the molded surfaces shall be rubbed to reveal the aggregate.

All arrises are to be left true to line, and such portions of the work, such as the tracery of the windows, dormers and balustrades, as demand particular care, shall be assembled and the joints ground to insure a perfect alignment.

No piece shall be less than 4" in thickness, and all the work shall average a 6-in. bed, and care is to be taken that the beds of the joining pieces shall vary, to permit of proper bonding. Anchor holes shall be provided in the rear of each block or stone, or where directed.

At least 1 mo. must elapse between the date of casting and the date of erection.

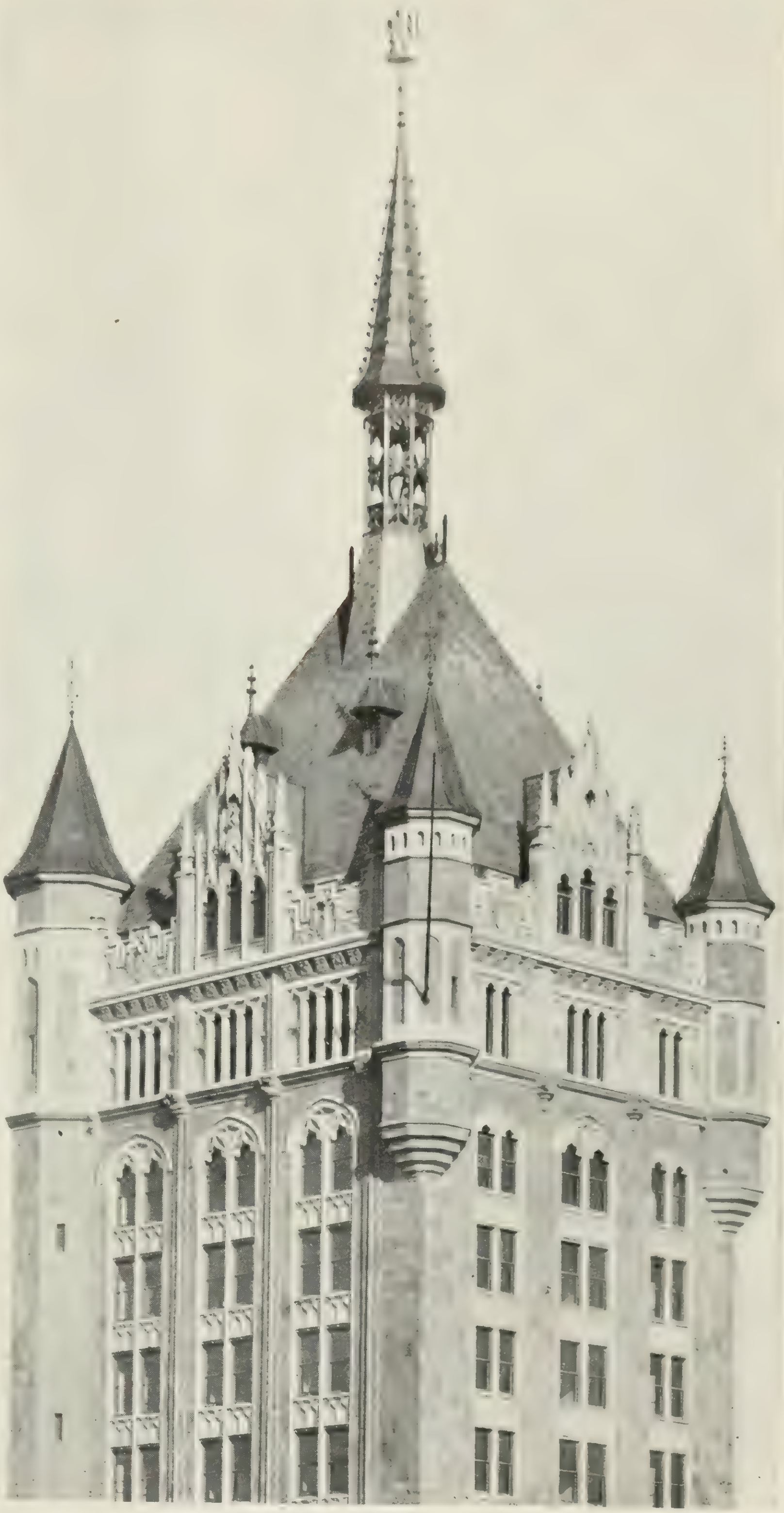
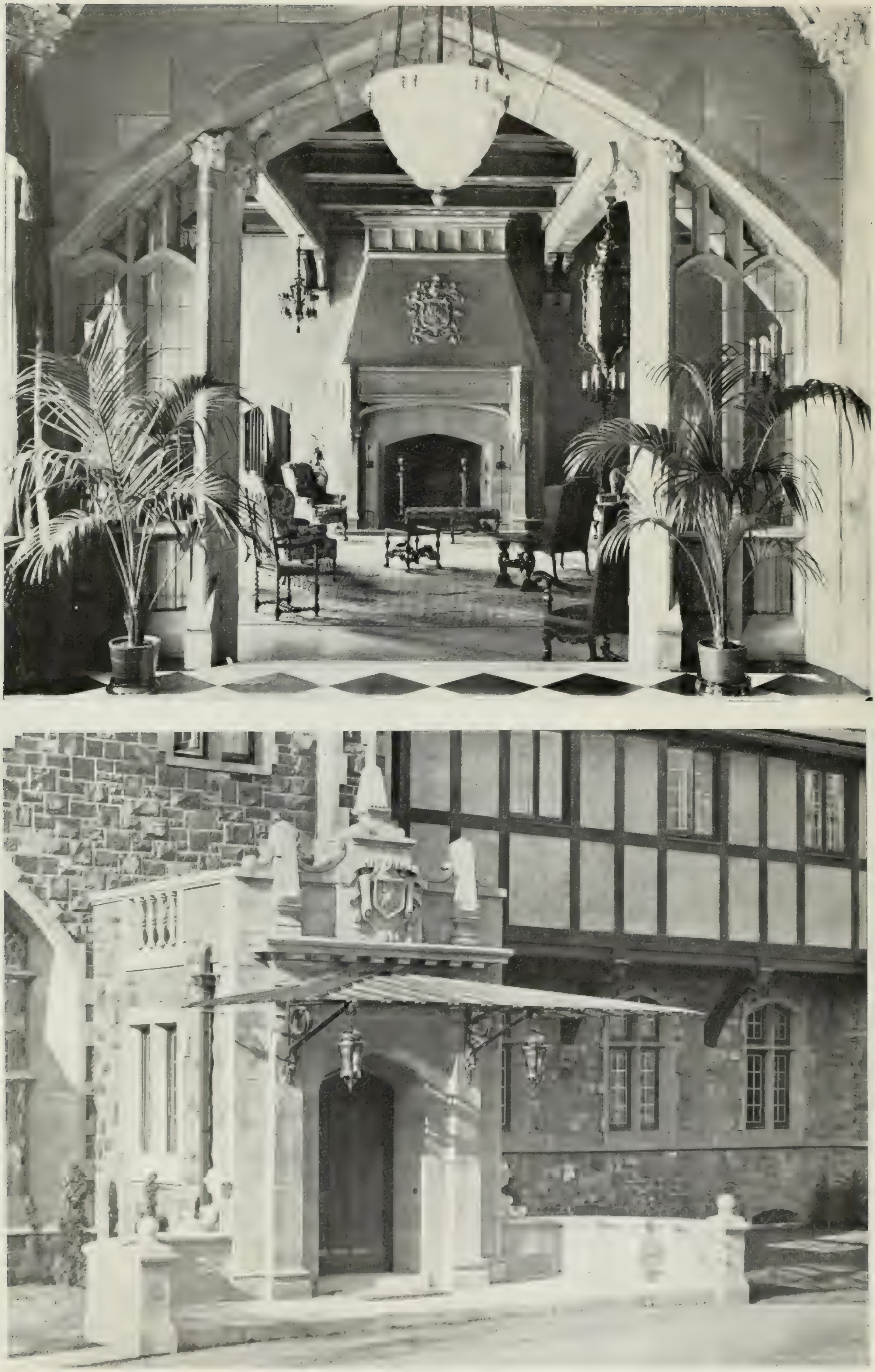


Fig. 6—Tower, Delaware and Hudson Building

Where reinforcements are required, as in the supports for the tourelles, they are to be of a minimum cross-section of 6/10 of 1%.

All ornamental portions shall be modeled in wax or clay from the architect's detail drawings, and shall be submitted to the architect by photograph or offered for his personal inspection. The modeling shall be artistically executed by a modeler familiar with Gothic detail, who will be permitted considerable latitude in order that the owners may benefit by his skill. All ornament is to be undercut and sharpened by hand.

Actual experience has shown that the artificial stone, which in the present case is exposed to the smoke of the railroads, as the building imme-



Two Views of Residence of Frederick F. Brewster, New Haven, Conn., Showing Use of Concrete Stone for Both Interior and Exterior Trim. Stone Made by New England Stone Co., New Haven diately adjoins the freight yard, has kept remarkably clear of discolorations. There are also none of the unsightly stains which usually make their appearance on limestone and sandstone. The pieces were not in objectionable wind, and the alignment throughout was almost perfect. Where carvings are called for, they are clean, sharp and fine, and could not be told from those executed in real stone. In short, I think that the use of the synthetic stone has given a more satisfactory building than limestone would have done.

EDITORIAL DISCUSSION

SAND MOLDS

The methods employed by manufacturers of sand-cast concrete stone have special interest in connection with the work on the Delaware & Hudson building. The following descriptions[2] of some of the more important features of this work:

The use of sand molds in making concrete casts is covered by patent. The use of sand in which are certain other definitely named ingredients, having a tendency, it is claimed, to prevent a rapid absorption of the excess moisture of the concrete mixture, is also controlled by patent. * * * Sand is used in which there is a certain percentage of loam and successful work is being done by using stone dust in place of sand.

For ordinary work the sand is used in large beds throughout the casting floor of the factory and is packed around patterns, which are drawn to make the molds.

Balusters, capitals and similar pieces having no large flat surface which may be left upward as the pattern is placed in the sand and toward which the pattern can be drawn are made by the flask method, in which a box for each of two or more portions of the pattern supports the sand for a section of the mold. The boxes are assembled to complete the mold.

Patterns—When sand molds are used the problem of the manufacturer is to make a pattern or model of the stone to be cast. The pattern must be so made as to be withdrawn from the sand without breaking down the mold. * * *

In Fig. 7 is a sketch of the pattern with the parts clearly indicated. It will be seen that the pattern is in four parts. The molded side is placed downward in the sand and when the sand has been tamped into place the pattern is drawn in the direction indicated by the arrow. It is obvious that any side projection in the pattern must be a separate piece and separately withdrawn. If drawn all at once the projections would break the sand mold. If there were but few such pieces to be cast it would be more economical—by saving time in making the pattern and in making the sand mold—to eliminate the small pattern part numbered 4, by filling in so that the pattern would draw on that line. The additional detail would then be cut in by stonecutters. Further illustration of splitting patterns is shown in Fig. 8.

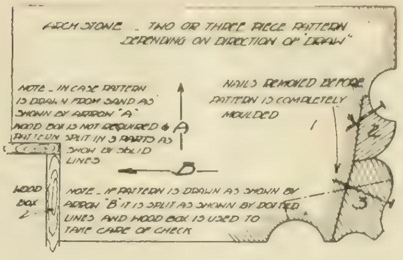

ARCH STONE _ TWO OR THREE PIECE PATTERN DEPENDING ON DIRECTION OF "DRAW"
NOTE _ IN CASE PATTERN IS DRAWN FROM SAND AS SHOWN BY ARROW "A" WOOD BOX IS NOT REQUIRED & PATTERN SPLIT IN 3 PARTS AS SHOWN BY SOLID LINES
NAILS REMOVED BEFORE PATTERN IS COMPLETELY MOULDED
A
B
1
2
3
4
WOOD BOX
NOTE _ IF PATTERN IS DRAWN AS SHOWN BY ARROW "B" IT IS SPLIT AS SHOWN BY DOTTED LINES AND WOOD BOX IS USED TO TAKE CARE OF CHECK

Fig. 7

It will be noted in the illustration that the parts of the pattern are held by nails which are withdrawn before the sand mold is complete. * * *

Wood strips are frequently used around the top of a sand mold to give firm edges which are not disturbed by workmen when the surface is smoothed off with a trowel after the concrete has been in place for a few minutes in which it has stiffened slightly by loss of moisture in the sand.

With the flask method of molding * * * it is common practice to mix the sand with plaster because, when the sectional molds have been made in the boxes, the boxes must be fitted together and stood on end. The parts are made to fit precisely by the use of dowels in the sections of the flask or the box or by cleats which engage at the corners. The flask, as completed, is filled through an opening in the top as made by a wood insert.

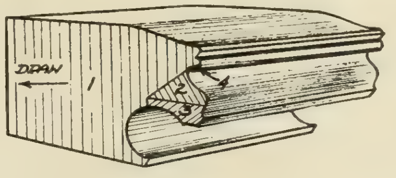


Fig. 8

In making an elaborate capital * * * it would be more economical to use a gelatin mold providing a full-size model were available. In this way all the detail and undercutting could be fully brought out. If one section of an hexagonal piece were available, it would be enough from which to produce a sand mold by the flask method, but the numerous sections of the flask and the resulting joints frequently give trouble. The use of two sections of the figure would be desirable so that a mold could be in but three sections. In this case much of the undercutting would be filled in on the pattern sections and the reverse molds would be made of a mixture of sand and plaster. The three sections, each being a reverse mold of two sections, could be placed together to make the mold. The three sections of mold when placed together would be backed up with sand to hold them securely.

Placing the concrete mixture in a sand mold should be done with great care. The mixture should be *smooth* and this depends upon care in the selection of materials and care in proportioning them and it depends further upon agitating the mixture up to the time it is poured. * * * A wetter mixture can be used in sand casting than in water-tight molds, because the excess water is taken up by the sand. A mixture should not be so wet as to cause a rapid separation of materials. To obviate that separation in the mixture, it is general practice to agitate the mixture after it comes from the mixer. This may be in a motor-driven agitator carried by an overhead crane, from which the mixture flows only a few feet into the molds. In some plants the agitator is driven by a crank operating paddles within a cask which is moved about on trucks over rails. The mixture is taken off in pails through a spigot and poured immediately into the molds. To some extent—and more notably in one very large eastern factory—there is no agitation of the mixture except by puddling with sticks after the mixture is deposited in wood molds. The mixed concrete—of a consistency to pour—is conveyed in 12-qt. pails, four at a time in wheelbarrows. When the mixture is deposited the spout or pipe from which it issues should be held close to the mold (a pipe can usually be lowered into the mold) so that the force of the impact will not disturb the sand. The pipe should have a short, trough-like piece of sheet metal at the end to break the force of the flow. If the mixture is not poured through a pipe direct from an agitator, the man in charge of the casting should use a short board or piece of sheet metal held in his hand, and the mixture should be poured against it.

Concrete Prevents Vibration in Cotton Mills

In buildings in which there is reciprocating machinery, like looms, all working together, the moving parts of which have a uniform speed, there is a large advantage in concrete, because the greater solidity and rigidity of this floor over that of any other type absorb this vibration in the same way that a heavy foundation absorbs that of a horizontal reciprocating engine. Aside from freedom from damage to the building by this vibration are the stability and free-running qualities of the machines themselves. This adds to their life and reduces the possibility of breaking the threads, which affects the cost of operating and the quality of the product. It has been found by some manufacturers that looms can be run 15% faster on a solid concrete floor than on a wooden floor subject to vibration. It has also been found that, due to the rigidity of the floor, there is a distinct saving in power.—L. C. Wason.

The use of concrete for roofs has simplified the waterproofing problem. Instead of using 5-ply roofing paper, 3-ply will be found ample. The saving from this source often exceeds 2 cts. per sq. ft., or $600 on a mill 75′ x 400′. The two extra plies used on a wood roof are needed to make a smooth surface, but the concrete roof is already smooth.

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[2] From *Concrete Stone Manufacture*, by Harvey Whipple, Concrete-Cement Age Publishing Co.

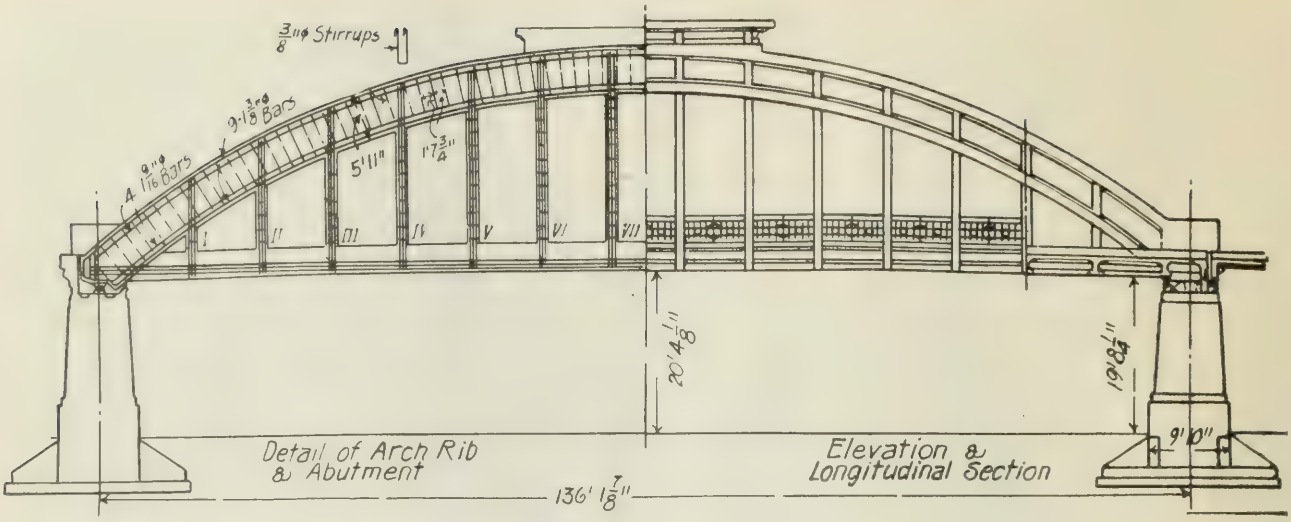

Fig. 1—Through Arch Bridge at Mestre, Italy

Notes on Design and Construction of Provincial Highway Bridge at Mestre, Italy[1]

By Albert M. Wolf, C. E.[2]

In the spring of 1912 a highway bridge was opened at Mestre, Italy, the next station to Venice, with a main span constructed as a two-ribbed arch with a suspended floor, having a clear span of 132′ 2⅝″ and a total width of 33′ 1⅝″. This structure marks a great advance in the art of bridge building and is worthy of note on account of the construction methods involved.

The structure carries the provincial highway from Mestre to Mirano over the State Railway lines of Mestre-Treviso and Mestre-Portoruaro in the vicinity of the main station at Mestre. This was accomplished mainly, by the aforementioned arch span with approach trestles at either end having a rising grade of 3%.

The viaduct with a total length of 1,640′ was built mainly to carry the electric street railway which connects the two towns. At first it was planned only for this street railway, but a very reasonable conclusion was finally reached, viz., that the entire street should be carried by the bridge. Besides this structure, two other reinforced concrete bridges have been built in the vicinity of Mestre which were also designed and constructed by Guiseppe Pasquali, engr., of Mestre. They are about 984′ long, with approaches on 4% grades and serve only to carry the electric street railway tracks over the railroad.

DESCRIPTION OF THE VIADUCT

As previously mentioned, the railroad tracks are spanned by an arch with a clear span of 132′ 2⅝″, at either side of which are a number of three-post, framed trestle bent spans approaches of 21′ 4″ span. These spans which lie in the form of a circle, have a beam and slab deck. In order to provide properly for the expansion of this long bridge, expansion joints are made at certain places by means of double bents, and joints in the deck.

After this short description of the beam spans, which structurally do not present any new problems, we shall take up the more noteworthy middle span. This span consists of two through arch ribs, 31′ 2″ o. c., from which the roadway is suspended. The arch rib thrust is taken up by tension members at the level of the floor system, and since one fixed and one movable bearing are provided, the piers are subjected to vertical reactions only. This design of supports was chosen to eliminate the influence of expansion, and also on account of the unsatisfactory foundation condition.

The clear space between arch ribs is 27′ 10⅝″, of which about 23′ is taken up by roadway and 2′ 5½″ on each side by walks. (See Fig. 2.) The theoretical center to center span of the main rib is 136′ 1¾″ and the rise of their middle line is 24′ 7¼″. Their theoretical rise center to center is 31′ 2″.

The arch ribs of I-section are 5′ 10⅞″ deep and 3′ 3⅜″ wide, with a web 11¾″ thick, reinforced at extrados and intrados with nine 1⅛-in. diam. bars and four 1 3/16-in. bars at the inner sides of the rib flanges. The bars are tied together at intervals of 20-in. x ⅜-in. stirrups as shown in Fig. 3. The middle portion of the arch rib is braced against wind stresses by transverse struts of reinforced concrete.

The intermediate hangers are spaced 8′ 10¼″ apart and support the cross-beams, carrying the floor slab. The end hangers are placed 10′ 6″ from center line of abutments. The stringers between the floor beams are spaced 3′ 11¼″ o. c.; the outer stringers lie in the vertical members between ends of ribs. The plane of the arch ribs and are combined with the horizontal tension slab constructed integral with the stringers is 5″ thick. The tension members of arch ribs are reinforced with 56 13/16″ diam. bars in six rows, tied together with horizontal and vertical stirrups. The ends of the main bars are anchored at the ends, beyond the intersection with center line of arch rib, by passing them through plates and placing nuts on the threaded ends.

One end bearing of ribs, as already mentioned, is fixed, while the other is movable. The fixed end is built as a spring hinge, while the movable end is supported on a roller nest bearing similar to those heretofore used for steel bridges only. The steel rockers are 11″ wide and contained between two cast iron plates 2″ thick. Each spring hinge con-

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[1] Abstracted translation of an article by Theodore Gesteschi, Berlin; in *Beton u Eisen* No. 2, 1914

[2] Prin. Asst. Engr., Condron Co., Chicago

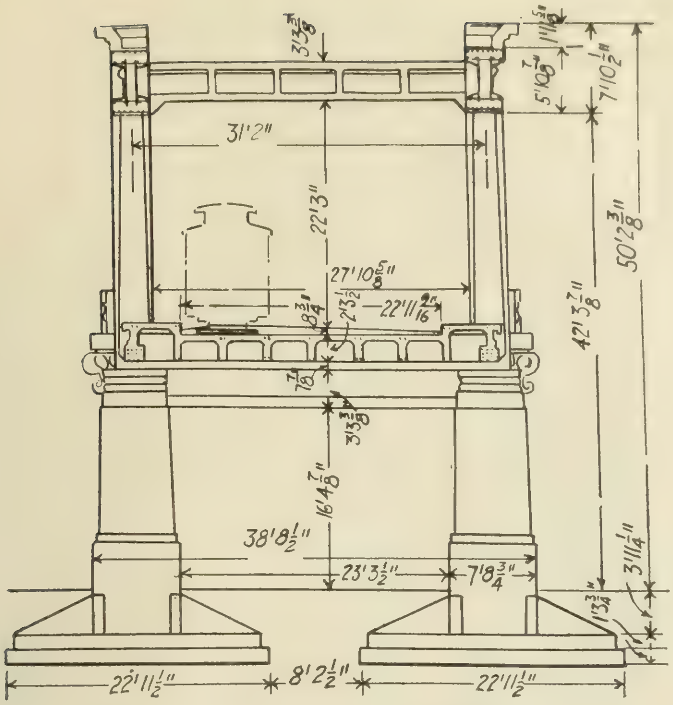

FIG. 2—CROSS-SECTION THROUGH ARCH AT MESTRE, ITALY

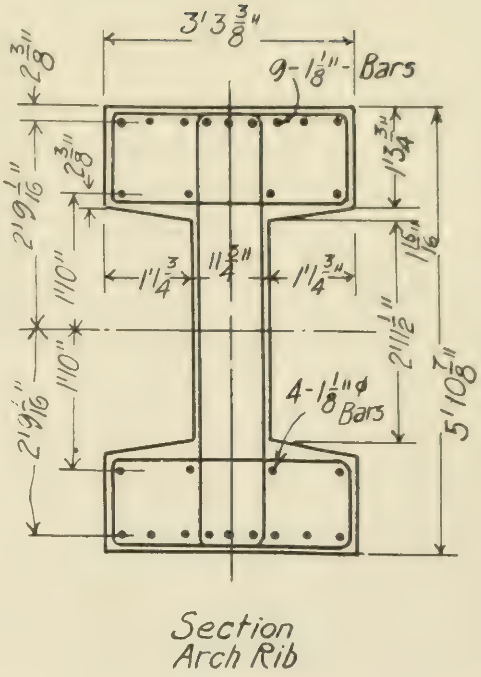

FIG. 3—DETAILS OF ARCH RIB, ARCH BRIDGE AT MESTRE, ITALY

sists of 24 $1\frac{3}{16}$-in. diam. bars, which tie the rib to the pier. By lacing in the ribs at this point and by diminishing the moment of inertia of the hinge cross-section in proportion to that of the arch rib a yielding of the support is obtained and a real hinge action set up.

CONDITIONS OF LOADING USED IN DESIGN

For the statical computation of the structure, the following loadings were prescribed by the Italian State Ry. Commission:

1. A crowd of people weighing 335 lbs. per sq. ft.
2. A double axle wagon with an axle load of 8 tons and six horses of ¾ ton each, hitched in pairs. The axles spaced 9′ 10″ centers, the width 8′ 2″ and the loaded length 52′ 6″.
3. An electric railway track with double axle cars 26′ long with axle load of 8 tons, axles 8′ 2″ centers, followed by trailers with 6 tons on each of two axles. For the axle loads an impact of 25% was allowed.
4. For wind stresses the following loads were considered: 168 lbs. per sq. ft. for dead load only acting and 100 lbs. per sq. ft. for live load acting.

The arch ribs were designed as two hinged with tension members, and two conditions of loading were taken into consideration, as follows:

1. Entire bridge loaded for greatest thrust.
2. One side loaded to ascertain the greatest moments. Temperature stresses were not taken into account for the system of supports used.

STRESSES

The horizontal thrust at the crown for dead load plus full live load amounts to 832,000 lbs. or 278.3 metric tons, while for dead load with live load on one half the structure the thrust is 730,000 lbs. or 331 metric tons.

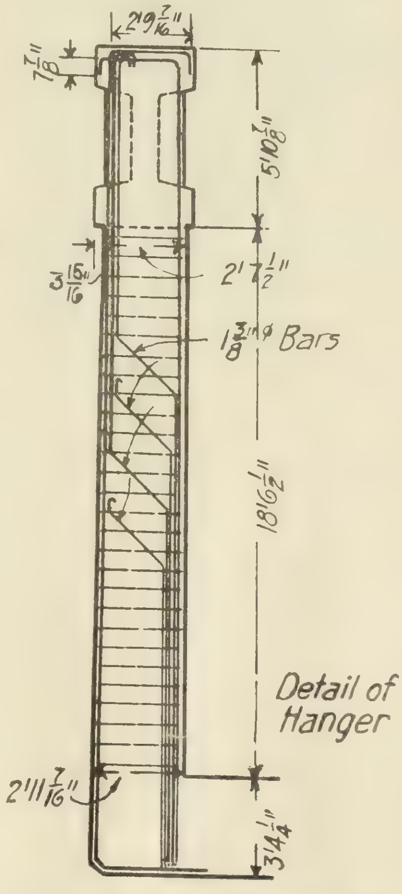

FIG. 4—DETAILS OF HANGER, ARCH BRIDGE AT MESTRE, ITALY

After computing the arch thrusts, the pressure lines were laid out for both conditions of loading. For full load the greatest eccentricity was at the crown and amounted to 10¼″ or 26 cm. and the greatest moment, 710,055 ft.-lbs. or 98.4 metric tons. For one half of bridge loaded, the greatest eccentricity occurred at about the quarter point and amounted to 13¾″ or 0.351 m. horizontally and 14¾″ or 0.375 m. vertically while the moment was 894,785 ft.-lbs. or 124 meter-tons.

Summing up we have the following:

(a) At the crown

Moments of Inertia: = 0.567 $m.^4$

Distance to extreme fibre: 2′ 11½″ or 0.90 m.

Horizontal Thrust: 832,000 lbs. or 378.3 metric tons

Bending Moment: 710,055 ft.-lbs. or 98.4 meter-tons

The cross-sectional area of the concrete at the crown of the arch rib amounts to 11.84 sq. ft. (1.10 m.), while the area of steel is equivalent to 2.47 sq. ft. (0.23 m.) concrete. The stress at the compression side of the arch rib at the crown is 626 lbs. per sq. in. (44.0 kg. per sq. cm.) and at the tension side 182 lbs. per sq. in. (12.8 kg. per sq. cm.) compression; the stresses at the crown are therefore entirely compressive.

(b) At the quarter points:

Moment of Inertia: = 0.567 $m.^4$

Distance to extreme fibre: 2′ 11½″ or 0.90 m.

Horizontal Thrust: 798,800 lbs. or 354 metric tons

Bending Moment: 894,785 ft.-lbs. or 124 meter-tons

Equivalent Cross-sectional Area of Rib: 14.31 sq. ft. or 1.33 $m.^2$

The stress at the compression side of the arch ribs at the quarter point is 654 lbs. per sq. in. (46.3 kg. per sq. cm.), and on the tension side 99 lbs. per sq. in. (6.9 kg. sq. cm.) compression. The stresses throughout the arch ribs are therefore compressive. The greatest tensile stress in the tension members is 13,700 lbs. per sq. in. (963 kg. per sq. cm.)

CONSTRUCTION AND LOAD TESTS

For the concrete mixtures used, 350 kg. to 600 kg. (770 lbs. to 1,320 lbs.) of Portland cement were required for one cu. m. of gravel (35.3 sq. ft.) in order to obtain the desired density. For the bridge seats of both ribs 600 kg. (1,320 lbs.) of Portland cement were used for one cu. m. (35.3 cu. ft.) of fine aggregate and 500 kg. (1,100 lbs.) of cement to one cu. m. (35.3 cu. ft.) of aggregate for the arch ribs.

While concreting it was necessary to provide a clear opening 49′ wide under the bridge in accordance with the requirement of the Italian State Ry. Commission. For this purpose, eight trusses of American pine were placed over the future roadway and the forms hung from these by means of hangers. These trusses were 9′ 10″ high. With the aid of wedges placed at different points on the trusses, the elevation of the forms was easily regulated.

The approaches were begun July 1, 1911, and the main arch in Oct. All concrete work for the structure was completed Dec. 31, 1911. The loading tests were made in Mar., 1912, about 60 das. after the completion of the concrete work. For the test load for quiescent load 680 kg. $m.^2$ or 139 lbs. sq. ft. of bridge floor of sand and gravel was used. The results were a total deflection of 7.3 mm. or $\frac{9}{32}''$ for the north rib and 6.6 mm. or $\frac{17}{64}''$. After this test no cracks or other dangerous deformations were discovered.

It is often necessary to divert temporarily small streams of water, particularly in bridge and culvert work. H. S. McKee, Erie, Pa., writes that strips of canvas tacked to rough supports so as to make a V-shaped trough are ideal for this purpose, as they are inexpensive, compact, flexible and quickly placed.

Permeability Tests on Gravel Concrete

A partial report on tests to determine the permeability of concrete to water, now being conducted at the Univ. of Wis., was read by Morton O. Withey, assistant professor of mechanics, before the West. Soc. of Engrs. at the Sept., 1914, meeting.

These experiments were started in the spring of 1912 at the suggestion of the Inspection Bureau of the Universal Portland Cement Co. The particulars in the method of conducting the tests which make them somewhat unique are the use of machine-mixed concrete, the employment of large specimens having a prescribed volume of concrete subjected to water pressure, and the measurement of the water entering the specimens during a large number of hours. The proposed program of experiments includes tests with different brands of cement on broken stone and sand, broken stone and screenings and gravel and sand aggregates. Only the tests on the latter combination with one brand of cement are herein considered, although work is now being done on mixes containing sand and broken stone. The reported tests include the effect on permeability of the following variables: age, thickness and consistency of concrete; time of mixing; graduation of the aggregate; wet and dry sand; fineness of cement; and curing conditions.

The materials used for making test pieces were Universal Portland cement, sand of 104.5 lbs. to 112.2 lbs. weight per cu. ft. with 0.19% to 0.29% absorption and gravel of 109.3 lbs. and 107.3 lbs. per cu. ft. and 0.63% and 1.40% absorption respectively. Of the test pieces 88 were proportioned, by volume, 1:1½:3 and 67 were 1:2:4; 98 were of 1:9 mixtures proportioned by weight.

CONCLUSIONS

From these tests the following conclusions are drawn:

1. None of the concretes tested was absolutely watertight if we consider flow into the specimen as proof of permeability, but the majority of the mixes were so impervious that no visible evidence of flow appeared. For most purposes such mixes can be considered watertight.

2. The visibility of dampness on the bottom of the specimens increased with the humidity of the air and the non-homogeneity of the concrete. The minimum rate of flow for which leakage was indicated was 0.00011 gal. per sq. ft. per hr.

3. In tests of nearly all of the properly made mixes of 1:7 proportions, or richer, the rate of flow for a 50-hr. period was less than 0.0001 gal. per sq. ft. per hr. under a pressure of 40 lbs. per sq. in.

4. Through increasing the fineness of the cement a reduction in the rate of flow and a considerable increase in the strength of a 1:9 mix were secured.

5. By grading the sand and gravel in accordance with Fuller's curve[1] it was possible to obtain practically watertight concretes of 1:9 proportions under pressures of less than 40 lbs. per sq. in. To secure such results, however, requires great care and careful supervision in mixing, in determining the proper consistency, in placing and in curing the concrete.

6. In the proportioning of such material as these, volumetric analysis, coupled with a determination of the density and air voids, yields very valuable information concerning the best proportions of sand and gravel for a given proportion of cement. If proportions must be selected arbitrarily a 1:1½:3 mix, by volume, is very impervious. It should be remembered, however, that the volume changes in rich mixtures due to alternate wetting and drying are much greater than for lean mixtures. Consequently due attention must be given to the provision of expansion joints and reinforcement in structures made of them.

7. The use of the proper amount of water necessary to produce a medium or mushy consistency is one of the most important conditions in securing impervious concrete, especially when lean mixtures are used. Dry mixtures cannot be sufficiently compacted in the molds and are more difficult to cure properly than the mushy mixtures. Although the use of a wet consistency does not materially affect the imperviousness of very rich mixes, such as 1:1½:3, it greatly increases the flow through a lean mix.

8. For lean mixes made from damp sand it seems advisable to mix longer than is now common practice. These tests would indicate that for a mixer running at 30 r. p. m., a period of 1½ min. to 2 min. is required to secure thorough mixing of a 1:9 concrete. For a rich 1:1½:3 mix a 1-min. period appears to be sufficient. The method of mixing in which water is first admitted to the mixer is to be condemned. A preliminary period of dry mixing lasting from 16 sec. to 30 sec. seems desirable.

9. In the manufacture of impervious concrete no stage or process is

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[1] Chap. XI, Taylor and Thompson's "Concrete, Plain and Reinforced"

of more importance than curing. The results of these tests clearly demonstrate that premature drying destroys the imperviousness of 1:9 mixes, seriously impairs that of the 1:2:4 mixes and somewhat diminishes that of the 1:1½:3 mixes. For thin sections, not over 6″ or 8″ thick, the curing conditions should be such that a lean concrete will be kept damp for a period of 1 mo. and a rich concrete for at least 2 wks. Even after 1 mo. of proper curing, complete desiccation of a lean mix composed of these materials produces an increase in permeability, but the effect on a rich mix is not marked.

10. In these tests the imperviousness of the concrete increased rapidly with the age of the specimens for the first month; thereafter the change was not marked.

11. From the tests thus far made it seems probable that the permeability of lean concrete in a direction normal to the pouring is greater than in the direction of pouring.

Sack Sense

A sack that carries its contents from the mills of the manufacturer to the ultimate purchaser, that is properly untied, that is kept clean and dry, that is not used as a covering for concrete nor as a tool-chest, nor as a knee, foot or back protector, nor as a hod-pad, nor as a shoe cleaner and that, having thus once served its legitimate purpose, finds its way back to the mills of the manufacturer within a reasonable length of time—such a sack is again available for use and is worth the sum of 10 cts.

A sack that, upon its arrival at the job is opened with a shovel, that is used to plug holes in the water barrel, that is used as a sun-shade for concrete in summer and as an overcoat in winter, that likewise serves as a workman's apron or tool receptacle, and that is commissioned for other miscellaneous purposes just because it is handy, that becomes dirty, wet and even torn in places—the value of such a sack has reached the zero mark and, consequently, the needless labor of collecting, sorting, counting, bundling and tying sacks so improperly used should be avoided and the freight on their return saved by the man who purchased and used the cement.—*Dealers' Record.*

Tools, pails, etc., that have become thickly coated with concrete can be cleaned by heating. A gasoline torch will aid in removing concrete from mixer and other large equipment.

Control of Reinforced Concrete Construction[1]

By W. K. Hatt[2]

A number of casualties have attended construction in concrete. A sudden collapse of a portion of a reinforced concrete building in a large city, attended with loss of life of workmen, generates in the public mind a fear of concrete construction; and a prospective builder is likely to resort to a less permanent and less fitting style of building because of the uncertainty. He knows that a concrete building is serviceable and permanent after the cement has set, but he fears the risk arising during construction.

Structural engineers, on the other hand, know that the percentage of failures is small, and the accidents to be avoidable.

Dangerous conditions in reinforced concrete construction arise from (1) inadequate designs; (2) defective materials, and (3) unfavorable weather conditions and lack of care under those conditions.

All of these elements may be, and are, controlled in the larger cities by building codes and active inspection. For instance, in the city of Chicago, which has an unusually efficient and watchful building department, there have been no serious failures of reinforced concrete buildings under construction. In this city designs are checked over very carefully to see that they conform with the conservative practice established by the building code of that city.

It is in the smaller cities, that are not large enough to demand permanent buildings, but without building codes, that the most dangerous conditions obtain.

The building codes are thought to be too conservative by some designing engineers of companies interested in the sale of materials. For instance, while these codes generally permit 16,000 lbs. stress per sq. in. upon ordinary reinforcing steel, some designers will increase this to 20,000 lbs. where the code does not prevent, and under circumstances where the sale of the material depends upon a low total price.

Many buildings have been erected under designs that are not conservative and yet have given good service. Their construction has been under favorable conditions with reference to cement, sand, weather conditions, and skill of workmen; and the lack of factor of safety in design has been counter-balanced by the increased factor of safety in materials.

Codes, however, must recognize average conditions. The architect or structural engineer or commercial firm supplying material, who has drawn upon the factor of safety in design, and then has met unexpected conditions in the materials, weather conditions, etc., and has a failure on his hands, is certainly in a weak position.

The larger number of failures of concrete buildings occur during the late fall when the low temperature and wet weather prevent the cement from hardening properly. At this time, too, the owner is anxious to get into the building. Every one is in haste; forms are struck before the concrete is hard enough to support the floors above; the roof, which is often the weakest part of the design, is being covered with cinders, into which the rain seeps. Instead of weighing 45 lbs. per cu. ft., the weight of these cinders may run up to 100 lbs. per cu. ft. Then, too, the plumber may seriously overload a portion of the floor with piles of pipes, may even remove a form support. Under these conditions it is no wonder that failures occur. In the presence of these unfortunate failures a designer who has furnished a conservative design is in a strong position.

The writer has investigated and made reports upon several failures in which it has been necessary to criticise the design. In some of these cases the architect has originally made a conservative design with sufficient materials and proper connections. The sales engineer of a company supplying steel has afterward prevailed upon the architect and owner to allow a substitute design. The latter is shaved down to the lowest limit, involving high stress in steel, short laps for bond, and defective continuity. While the substitute design will save in the cost of steel, the per cent saved on the cost of the entire building is usually small and will not justify the risk of the entire structure.

While recognizing the fact that methods of construction and dimensions of structures proceed partly upon experience and the desire for economy, the writer urges that, in the case of reinforced concrete, designs should follow bilding codes and the report of the conservative practice as fixed by the Joint Committee on Concrete and Reinforced Concrete which has recently been adopted by the A. S. C. E. and the Am. Soc. for Test. Mat.

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[1] *The Ohio Architect*

[2] Professer of Civil Engrg., Purdue Univ., Lafayette, Ind.

The standard designs of some of the constructing companies are also reliable and conservative. A special mention might be given to the Kahn standards of the Trussed Concrete Steel Co., Detroit, and those of the Corrugated Bar Co., Buffalo, for the dimensions of beams and girders of ordinary floors and roofs.

The codes, however, are naturally behind hand in respect to the newer forms of construction, such as the so-called "flat slab" design.

In construction with new materials the tendency is to follow forms that have been developed for old materials. Thus the first reinforced concrete buildings used the old wooden construction of girders, floor beams, and slabs between the latter.

In another line the first railway coaches were patterned after stage coaches.

Reinforced concrete, however, is continuous, like the old constructions.

The flat slab designs omit girders, and floor beams. There is a continuous slab over the entire floor, and it rests upon and is monolithic with the expanded heads of the columns.

The steel is disposed in either a four-way system or a two-way system.

These constructions are usually patented. Advantages are (1) the better lighting of the room, (2) the increased head room, (3) decreased story height, (4) more simple installation of sprinkling systems, (5) simpler form work, and (6) a construction more in keeping with the material.

The construction is generally considered more suitable for loads up to 500 lbs., and columns spacing up to 24′ than for larger loads and wider spacing. When the panel becomes rectangular instead of square, the long side should not exceed the short side more than $\frac{1}{3}$ part.

The depth of slab should be at least $\frac{1}{30}$ the span between column centers.

The design of the expanded head of the column needs attention. It should be stiff.

The steel is in the bottom of the slab at the center of the panel, and passes up to the top of the slab near the quarter point of the span.

The steel that passes from one panel to another should lap well over into the next span at least 60 diam. beyond the edge of the column cap. And where both bars are counted upon as reinforcing over the column, they should keep well up in the top of the slab over the column, and run 60 diam. beyond the quarter point of the span.

The amount of steel should be about the same in the various patented arrangements for given loads and spans.

Over the column head, the amount of steel should be sufficient to resist an external bending moment eual to $\frac{1}{15}$ W/L (for interior square panel); where W= total load, live and dead, on panel; L= span center to center of column along direct line.

Concrete Bridge Floors[1]

In the Cleveland work, it was required that the railroad bridge floors be relatively noiseless and waterproof. In former years every effort has been put forth to build shallow floors so as to minimize the change of grade. Such floors have always permitted the muddy water to seep through upon people passing below and have operated as drums in accentuating every sound from the passing trains. To overcome these defects the floors were made of I-beams and concrete slabs upon which tracks were laid and ballasted as upon the ground. Such a design requires a greater depth of floor, which means a greater change of grade, and more steel to carry the added weight of concrete. The bridge is therefore more expensive; but in cities where the noise is troublesome, the ballasted floor is a great improvement. Trains passing over such floors are noticed but little more than when passing over solid ground.

A concrete floor slab can also be made reasonably watertight. The writer's first experience with concrete was on the Missouri in 1887-88. Later it was used a little on the New York state canals, and still later in bridge construction on the Nickel Plate. During this period many experiments had been made and papers written in which it was sought to demonstrate that concrete can be made practically impervious to water and also that it cannot. Much concrete had been built that was very porous and there sprung up numerous business enterprises for the manufacture and sale of waterproofing material. Both observation and experience indicated that watertightness could be secured by either concrete alone or in combination with waterproofing. The requisite seemed to be that the material and workmanship should be the very best. If poor waterproofing were placed over poor concrete, the structure would leak. If the concrete were good, it would hold water, either with or without the waterproofing.

Especial efforts were made to avoid the entrance of water between the steel and concrete and at points of contraflexure and where cracks might develop from temperature changes. Bevel flashings of steel were riveted to the girder webs and malleable cast flashings were fitted around the stiffeners to cover and seal the edge of the concrete. This design was very successful. At points of contraflexure over curb supports and at Cedar Ave. over the center columns, it was realized that cracks would develop and an attempt was made to forestall their appearance by the construction of joints. The joints were carefully provided with gutters and drainage pipes, and it was hoped that no trouble would be had with the water. The cracks were successfully forestalled, but the drainage was unsuccessful. The channels soon became clogged with cinders and the details of the steel work in the gross-girders did not leave room for a sufficient body of concrete, and in some instances the concrete proved imperfect. So, while the slabs proved generally tight, there has been some leakage at the points of contraflexure.

Much reliance had been placed on the use of direct labor and carefully selected foreman, but there came a great rush of work at a critical time and the floors suffered. In East Cleveland at a later date, it became necessary to build waterproof joints at the hinges of the arch bridges.

The concrete in the floor slabs cost about $12 per cu. yd. in place.

Now that the bridges are completed and have been two or more winters in service, the conclusions are as follows:

1. Concrete can be made watertight, under low heads, for all practical purposes.
2. The mixing, placing and ingredients of concrete are subject to such a great number and variety of defects that only the keenest attention will secure an impervious structure.
3. Contraflexure temperature changes and settlements will produce cracks.
4. It is best to forestall cracks with predetermined joints.
5. Joints may be sealed against water if well designed.

On the underside of the bridge floors the concrete is protected from locomotive blasts by cast-iron plates, $\frac{1}{2}$″ thick and 36″ wide. They weigh 71 lbs. per lin. ft., and cost $5.23 per ft. in place.

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[1] Abstract from The Elimination of Grade Crossings on the N. Y., C. & St. L. R. R. in Cleveland, O., by A. J. Himes. Bulletin No. 160, A. R. E. A.

The Construction of the Sooke Gravity Flow Line at Victoria, B. C.

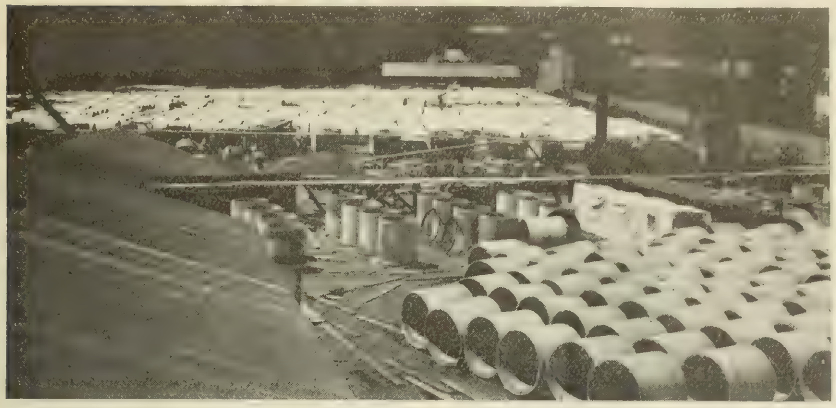


Fig. 1—Arrangement of Yard for Handling Concrete Pipes Used in the Sooke Lake Water Supply, Victoria, B. C.

The gravity flow line conduit shown in Figs. 1 to 7, inclusive, and described in the following article is now under construction for the Sooke Lake water supply at Victoria, B. C., to carry 18,000,000 Imperial gals. per 24 hrs.

The work consists of the installation of 27 mi. of 42-in. reinforced concrete conduit, of which 26 mi. is gravity flow line conduit laid on a grade of 1′ per 1,000′. The remaining mile consists of six inverted siphons, varying in head from 40′ to 100′. As will be noted from the illustrations, this pipe is laid for the greater part of its length, upon a bench, and without backfill.

DESIGN OF PIPES

The conduit was manufactured in sections at a central plant located 17 mi. from the upper end of the line. Each section is 4′ in length. The gravity flow line sections are 3″ in thickness of 1:2:4 concrete, and reinforced with one layer of No. 6 wire mesh.[1] The sections of siphon pipe are 4½″ thick of 1:1½:2½ concrete and reinforced with square twisted bars. These siphon pipe were made of five different types to withstand heads varying by 20′, and were reinforced as follows:

20′ and Less	¼-in. bars 3½″ o.c.
From 20′ to 40′	⅜-in. bars 3½″ o.c.
From 40′ to 60′	½-in. bars 4½″ o.c.
From 60′ to 80′	½-in. bars 3½″ o.c.
From 80′ to 100′	⅞-in. bars 4″ o.c.

The joints were of the "Lock Joint" type, made under the Meriwether system.[2]

MANUFACTURE OF PIPE

The pipe were manufactured in three different yards, each having its own mixing plant. The yards were so arranged that the pipe was cast in rows of four, as shown in Fig. 1. As soon as a row was cast it was covered with canvas and steam at a temperature of about 127° F. was turned into the molds containing the pipe. The application of this steam lasted for a period approximating 6 hrs. At the end of this period the forms were removed from the pipe. On the following day the pipe was removed from the base upon which it was cast, turned upon its side and rolled into the yard.

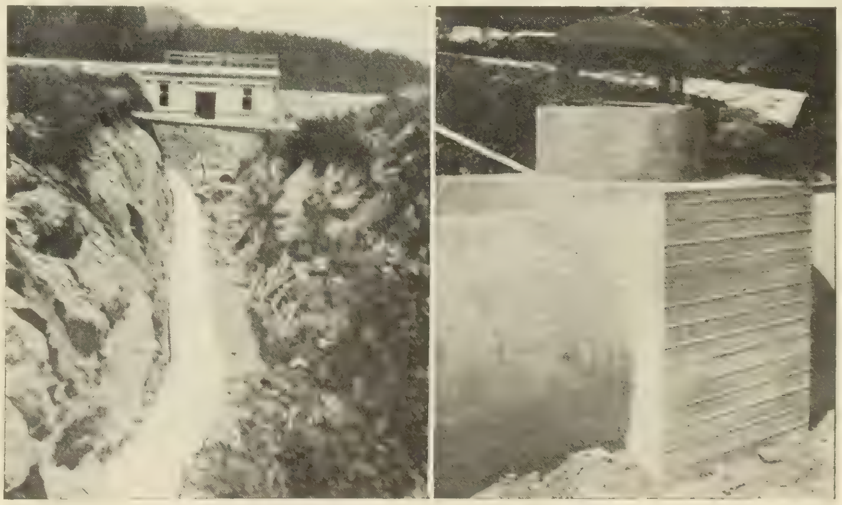
After a period of about 3 wks., during which time the pipe was constantly sprinkled, it was loaded upon cars and delivered to its final location on the grade. This was accomplished by means of a 24 in. narrow-gauge construction railroad. The pipe was delivered in trains of 12 cars each, each carrying two sections of pipe. Upon arrival at its destination each pipe was removed from the cars, inspected and laid. Inasmuch as the construction railroad was built upon the same center line as the pipe line, it was necessary to remove the rails as fast as the pipe was unloaded.

CONSTRUCTION DETAILS

In order to provide for drainage under the pipe line, the conduit was laid upon 3″ of crushed rock and this was carried up to the quarter-point on each side of the pipe. This pipe was brought to accurate grade by the use of a level rod on each section. After the sections were in place they were grouted together with 1:2 grout.

Inasmuch as this line was not designed to withstand any head, the valves regulating the flow of water through the line are installed at the intake at Sooke Lake (see Fig. 2).

One thousand feet below the intake is a spillway so constructed that water will be wasted should the head rise more than 3″ above the flow line. At each 2,000-ft. interval, and at each end of all inverted siphons, there is constructed a ventilator 2′ in diam. which rises 24″ above the flow line, and is covered with a metal screen, as shown in Fig. 3. These are both for the purpose of furnishing access to the interior of the pipe line and to allow for an overflow should an obstruction cause an increase of head at any point. A 6-in. blow-off valve is installed at the bottoms of all siphons. These siphons also have copper expansion joints installed at points at which there is a change in the direction of the line. At the drainage crossings, the pipe is



Figs. 2 and 3—Intake and Stand-Pipe, Sooke Lake Water Supply

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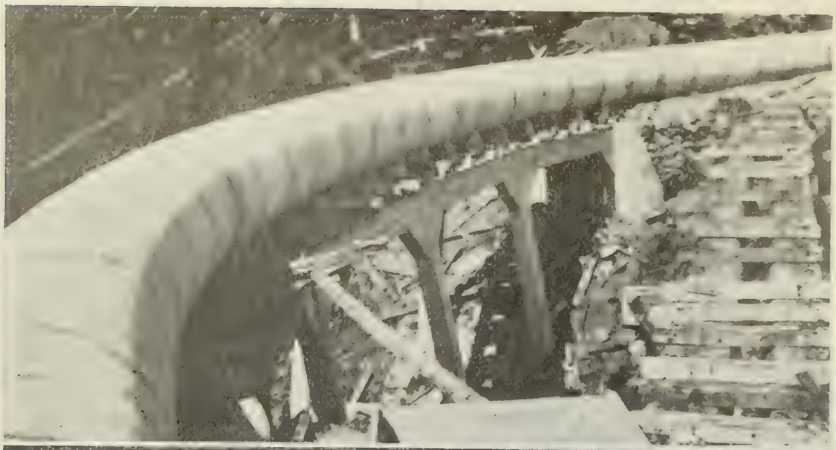
[1] Am. Steel & Wire Co., Chicago

[2] Lock Joint Pipe Co., N. Y. C.



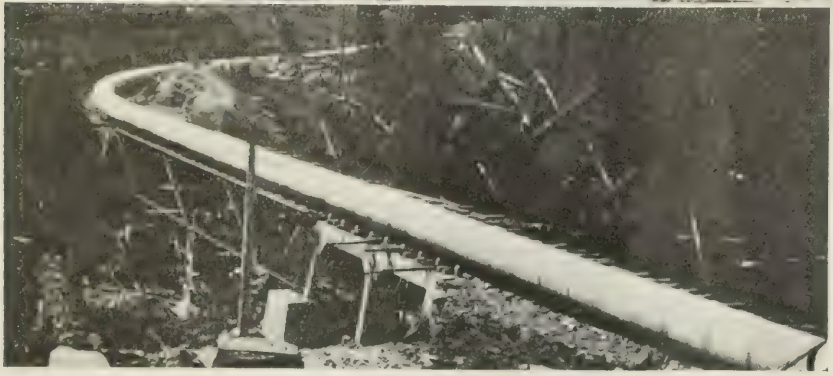


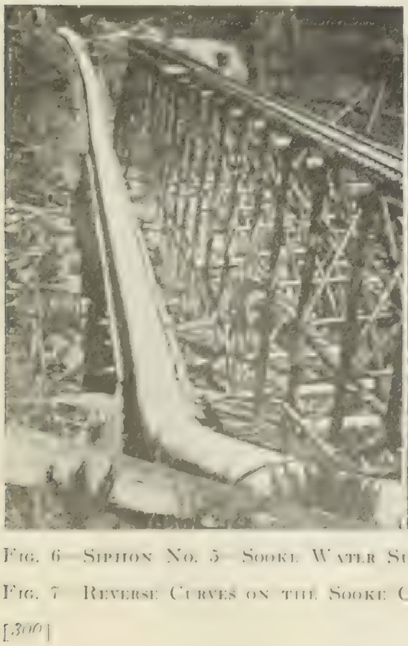
Fig. 4—Pipe Laid on Trestle on 75-Degree Curve

Fig. 5—Sooke River Crossing—Siphon No. 1

supported upon reinforced concrete trestles, the type of which is shown in Fig. 4.

One of the unusual features of the line is the large proportion of pipe which is laid upon curves. Of the 144,000′, 71,300′ are laid upon a tangent, and the balance upon curves, (see Figs. 5, 6, 7 and 8). Approximately 50,000′ of the curved portion is upon curves varying between 50° and 75°. These curves were turned with pipe beveled at one end, the error in joining caused by this method being too slight to be noticeable.

As the pipe is laid it is bulkheaded in sections of 2,000′, filled and tested. These bulkheads are constantly moved ahead so that the total pipe laid is filled and tested as the work proceeds.



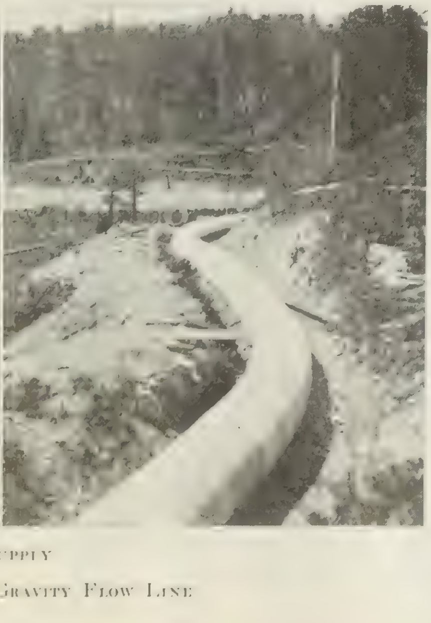
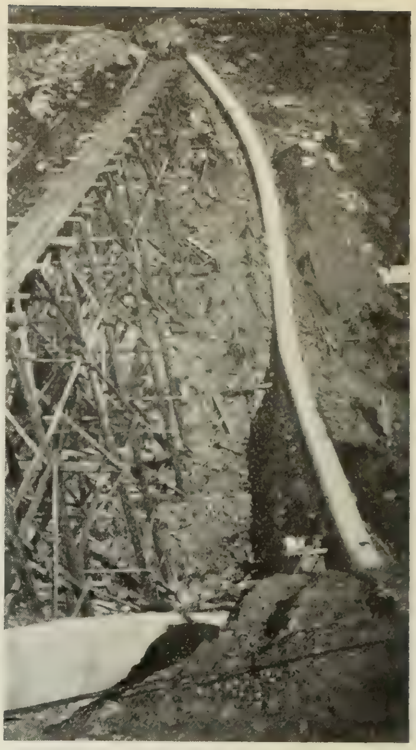


Fig. 6—Siphon No. 5—Sooke Water Supply

Fig. 7—Reverse Curves on the Sooke Gravity Flow Line



Fir. 8—Siphon No. 3—Sooke Water Supply

Permanence of Concrete Roads

According to the eighth annual report of the Bd. of Co. Rd. Commrs. of Wayne Co., Mich., there are now over 100 mi. of concrete roads in the county, some of which have given nearly 6 yrs. of service. That the adoption of the concrete road as standard is fully justified is shown in the fact pointed out by the commissioners that there have been no developments of ruts, and not a single 25-ft. section has had to be taken up and replaced.

Curing of the concrete after laying is an important matter. Following the laying of concrete, it is covered with 2″ of sand or loose soil, and this is sprinkled daily for 10 das. The road is not opened to traffic, however, until 3 wks. to 6 wks. have elapsed, according to the season of the year.

It is far too common practice to leave mixers and other mechanical equipment exposed to the weather when idle. A good tarpaulin cover costs less than 1% of the cost of a new piece of equipment and is low insurance.

This is the time to build concrete silos. Remember what the government says: "When every farm where stock is fed has a silo, an annual waste of nearly a thousand million dollars will have been eliminated."

Methods Used in Constructing a 108-Ft. Monolithic Concrete Silo Near Salona, Pa.

The concrete silo shown in Figs. 1, 2 and 3, was erected in the summer of 1914 by the Quality Farm Products Co. near Salona, Pa., for a local creamery company.

GENERAL DESIGN

The silo is 16′ in diameter and 108′ high, with a capacity of 610 tons, as shown in Fig. 2. The early silos rarely exceeded 30′ in height, but with the advent of concrete as a building material, and the invention of commercial forms for monolithic concrete construction, the average height has increased until 60-ft. and 70-ft. structures are quite common. The present silo is claimed to be a record breaker in height and economy in use, as the costs of silos vary inversely as their height. For instance, comparing the capacity of a 60-ft. silo with a 40-ft. silo of the same diameter, it is found that the former has nearly twice the capacity of the latter, and costs only about ⅓ more.

The foundation is 10′ below grade with a circular footing 24″ wide. The walls are uniformly 6″ thick throughout, reinforced both ways with square twisted steel bars as shown in Fig. 2.

The silo is built with a continuous chute, 8-in. round openings were provided at regular intervals during the Fig. 3. For admitting light to the concrete chute as shown in section in construction of the work.

The elliptical openings shown in Fig. 2 are 20″ x 30″ in size and spaced about 24″ apart. The oval shape was chosen in order to avoid sharp angles, which usually cause air cracks in the jamb in closing the doors when filling the silo.

The doors are made of heavily galvanized sheet steel, cut to fit snugly in a concrete jamb made by a sheet steel door form used in connection with the silo forms, flush with the inner wall and bent to the radius of the silo. On the outside of the door are fastened four malleable clips in which hook-bolts engage, an arrangement that makes a flexible fastening. Across the opening on the outside of the silo wooden bars are placed through which these bolts pass. The desired stress is obtained by malleable tail-nuts. This combination gives a light, durable door that is air-tight.

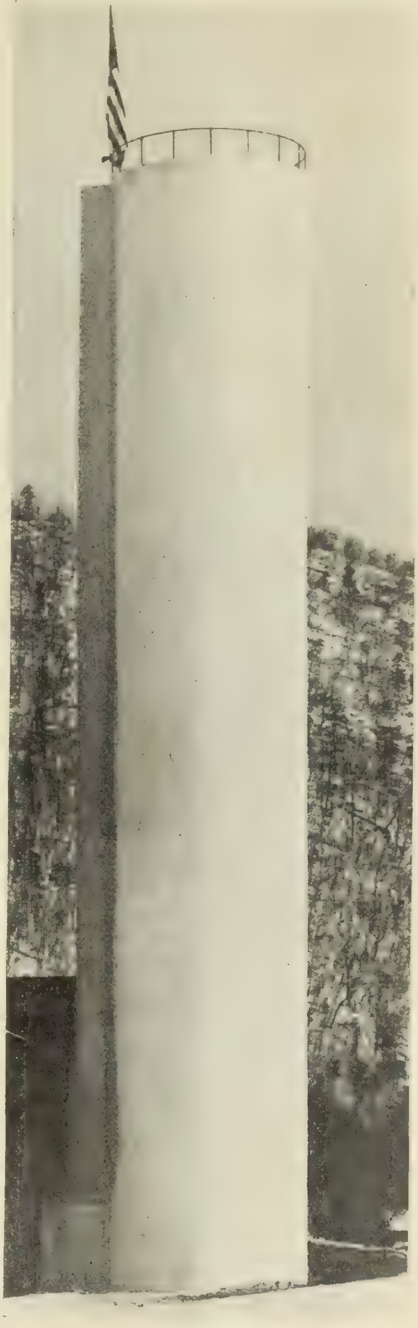


Fig. 1—A Monolithic Concrete Silo, 16′ in Diameter and 108′ High, Erected Near Salona, Pa.

It will be seen from Fig. 2 that the steel reinforcing increases from the top downward, so as to provide for the increasing pressures toward the bottom. This pressure does not, however, increase directly with the height, for by the comon theories of earth pressure the friction against the sides below a certain depth equals the additional weight of the ensilage, so that no matter how tall the silo, the wall pressure per sq. ft. never exceeds a certain amount, a fact said to be fully demonstrated by practical experience.

MOLDS AND EQUIPMENT

The apparatus used in building the silo carries its own scaffolding and is automatically lifted, thus imposing no strain upon the section of wall already built.

The machine is set up with a 4-in. steel pipe center mast placed in the center of the floor of the silo and is carefully plumbed by means of guy-wires attached to the top and provided with turn-buckles. The center mast is provided with a series of transverse holes to receive a heavy steel pin, which supports a widely flanged collar, which in turn supports the jacks by which the forms are lifted. Resting upon the jacks is a hub, consisting of a flanged base collar and a top dished collar connected by a central pipe of sufficient diameter to work easily over the center mast.

From the base collar of this hub radiate steel T's, which are supported from the upper collar by adjustable hanger rods with chain clevises.

Each form consists of eight separate sections and each section is reinforced and stiffened by a steel angle frame around the edges. The inner and the outer steel wall forms are rigidly bolted to the radiating steel T's, thus insuring perfect curvature and alignment for every portion of the wall. The outer sections are bolted together at their ends through holes in the frames. The inner sections are similarly bolted together at their ends but carry a steel wedge between them, the lifting of which allows them to swing free.

In order to keep the vertical reinforcing bars in their proper positions in the wall, small steel clips are provided, through which the bars pass. These clips fit over the stems of the steel T's.

For placing the concrete in between the forms a V-shaped dumping bucket is provided, being supported by a crane pivotally attached to the center mast directly above the top collar of the hub, and thus allowing it to be easily swung to any part of the wall space. The bucket is hoisted by means of a rope and a series of pulleys, so arranged that the hoisting force is applied horizontally from without the structure. A small opening, through which the hoisting rope works, is cut in the wall near the bottom of the first pouring of concrete. When the bucket is hoisted it is coupled to a carrier on the crane by means of a hinged hook and is

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[3] Polk-Genung-Polk Co., Fort Branch, Ind.

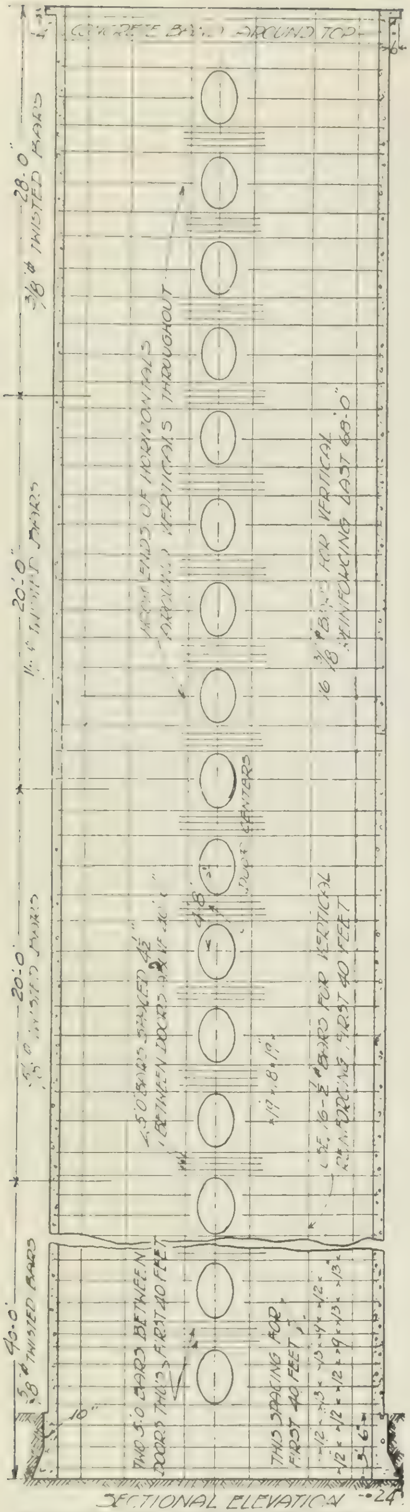

Fig. 2—Sketch Showing Details of 108-ft. Concrete Silo Near Salona, Pa.

then swung to any desired part of the wall space.

The scaffolding, both inner and outer, is swung from the steel T's which project some distance beyond the wall. The above mentioned heavy steel pin through the center mast carries the entire weight of the machine and workmen so that the green wall is entirely free from strain.

The foundation of this silo was started 10′ below the surface as shown in Fig. 1, and the structure was built up at the rate of 4′ per da. Each morning the segments of the forms were unbolted and loosened from the wall which was poured the previous day. The entire machine was quickly jacketed up 4′, the segments again bolted together, the reinforcing placed in position and the forms filled with concrete, which set over night. The next morning the whole procedure was again followed from day to day, until the desired height was obtained. The raising of the forms required on an average about 10 min.

PLACING THE REINFORCEMENT

The vertical reinforcing was first placed in position in convenient 10-ft. lengths. The horizontal reinforcing was then bent to the proper radius on the bar-bender, a part of the equipment furnished with the machine, and afterwards inserted between the forms under the steel T. It was then securely wired at intersections to the vertical bars. The ends of all reinforcing bars were lapped a distance equal to 36 diam.

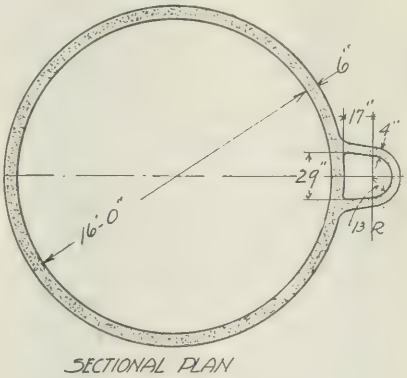

Fig. 3—Cross-Section Showing Chute

CONCRETE WORK

The mixture for the silo was in the proportions of 1 part Portland cement, 2 parts coarse sand and 4 parts screened and washed gravel.

An elliptical-shaped sheet steel door form was set between the forms as the work progressed. This form molded a concrete jamb 1″ wide and ½″ in depth from the inner surface of the wall. As soon as the machine had passed the opening the form was removed, leaving the opening in good condition.

SEALING SILO DOORS

In sealing the silo doors, a thin gasket of moist clay was smeared around the inner surface of the jamb; the door was then set in place and drawn tight by turning the tail nuts by hand. When the silage is fed down past the doors, they are replaced in the openings and it is necessary when refilling the silo only to smear the mud gasket back of the door and draw it tight. It is then always in the place in which it is to be used.

Economies in Concrete

In spite of the steady increase in the most of materials and labor the cost of reinforced concrete buildings has not advanced greatly in the past few years.

The reason for this seeming paradox is indicated by the following quotations from Leonard C. Wason, Pres. Aberthaw Constr. Co., Boston. He says:

> Some years ago when we simply sent the foreman a set of blueprints of the building and said "Go ahead and built it," leaving him to work out his own form designs, column forms used to cost, for direct labor, as much as 18 cts. per sq. ft., and floors 12 cts. per sq. ft.
>
> Now we spend much time in the office making plans—sometimes as many as 45 sheets of form details for a simple building. These designs may cost 2 cts. per sq. ft. of form-work. But now if the cost of labor for floor forms runs over 4 cts. per sq. ft. we want to know what is the matter; if it runs over 7 cts. a column we usually make a row. We have come to the conclusion that $1.00 spent intelligently in the drafting room usually saves $10 on the work—sometimes more.

That Mr. Wason believes in steel forms where they can be repeatedly used is evidenced by a recent statement as follows:

> When steel forms are leased and returned they cost 30 cts. per sq. ft. With wood, on the average, 3 cts. per superficial ft. of contact is the cost when used four times. Thus, it is necessary to use steel forms 10 times to bring the average material cost down to that of wood. But with wood the forms are so much shaken and damaged that after three or four uses they are practically worn out and have to be replaced. We used steel forms an average of more than 13 times on one job and they were still in good shape.
>
> We have never used steel forms to destruction, although we have used them 30 times. Probably 45 uses is a conservative estimate of their life. In this period 3 cts. per sq. ft. may be spent for upkeep, and when they are worn out the same 3 cts. can be obtained from the metal as junk. If the forms are bought at 45 cts. per sq. ft. instead of leased at 30 cts. the cost per use would work out finally at 1 ct. to which should be added ½ ct. for wedges and keys. This total is just half the cost of wood.

When contracting for building a silo don't forget that often the farmer may be induced to put in small work such as walks, feeding platforms, hog wallow, etc., that will keep your crew and mixer busy at the end of the day when the silo forms have been filled and thus turn back a good profit.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Field Examination of Concrete Sand

Discussed By Sanford E. Thompson,[1] John T. Simpson,[2] H. J. Kuelling,[3] Leonard C. Wason,[4] William M. Kinney[5]

"We should like instruction in identifying the best kind of sand for concrete—identification to be made in the field without any elaborate laboratory equipment. What is the best practice in determining qualities? What general instructions are there as to the sands which are always to be avoided? What are economical methods for the elimination of foreign materials from the sand?"

By Mr. Thompson

Experience has proved conclusively that there is, as yet, no means of distinguishing positively in the field between a good and a bad sand. Every sand from a bank which has not been tested previously should be subjected to laboratory test before being used in concrete.

This may seem a radical requirement, but it has been proved valuable by case after case occurring in practice, when a sand of excellent appearance has failed to set up.

Our Committee C-9 of the Am. Soc. for Test. Mat. is now investigating this problem with a view to determining the causes other than fineness which prevent the hardening of mortar and concrete even when made with first-class cement.

By Mr. Simpson

During the 11 years the writer was identified with the American Concrete Steel Co., of this city, a very simple method of testing sand was used, which, for all practical purposes, seems to be efficient.

A number of samples of sand are taken from the materials delivered and are placed in a milk bottle, filling the bottle to about ¾ of its height. Clear water is then poured into the bottle until it is almost full, the cap is put on and the contents thoroughly shaken until the sand is well washed. The bottle is then allowed to stand undisturbed for a number of hours, until the water on the top of the sand becomes perfectly clear again. In most cases, when the sand is taken from a bank and unwashed, a layer of sediment is deposited on top of the sand, and by comparing the height of this layer of sediment with the height of the column of sand, a close approximation of the percentage of loam can be arrived at. It was the practice of the writer to keep the percentage of loam down to 5%, or under, although in some cases as high as 10% has been used in emergencies, when a cleaner sand could not be obtained. A test of this kind affords a close approximation and as any workman at the building can make the test, it is a really a very practical one, as it oftentimes prevents the delivery of materials on the site which would later have to be hauled away.

By Mr. Kuelling

If the sand is for a concrete road or an important structure of any kind, I would not use it without laboratory testing, at least as to its grading, cleanliness and general physical composition, and if in a strange territory, I would make tests relative to its strength. If used for some minor purposes a man with laboratory experience on sand testing, or a man with considerable concrete experience could make a fairly good inspection in the field. Under no conditions would I leave the selection of sand to an inexperienced man.

Assuming that the man in the field has a couple of sieves, he can arrive at a fair idea of the gradation by sieving and measuring a composite sample. If the man has ideas, and cares to, he can plat this information on a standard curve. He must not forget, however, that when separated into sizes, the percentage of voids in each size differs considerably from the composite samples. Generally speaking, the sand with the larger percent of coarse particles, that is, those from $\frac{1}{16}''$ to $\frac{1}{4}''$ in size, is very likely to give better satisfaction for concrete purposes. This statement, of course, should be considered only when there is sufficient of the finest sand to fill the voids in the coarser.

An idea of cleanliness can be gained by noting whether or not the sand is coated with clay. Another good test is to take a thoroughly dry sample and after shaking vigorously, note whether or not much dust arises. Another test is to mix some of the sand with water and note the degree of cleanliness in the water.

In noting the general physical composition, the inspector should note the presence or absence of mica flakes, as their presence is very detrimental. He should also note roughly what proportions of the sand are silica and limestone. The larger the percentage of silica, naturally, the better the sand. He should note the composition of individual grains, whether hard or soft, sharp or round, stratified or unstratified. He should note the possibility of foreign matter

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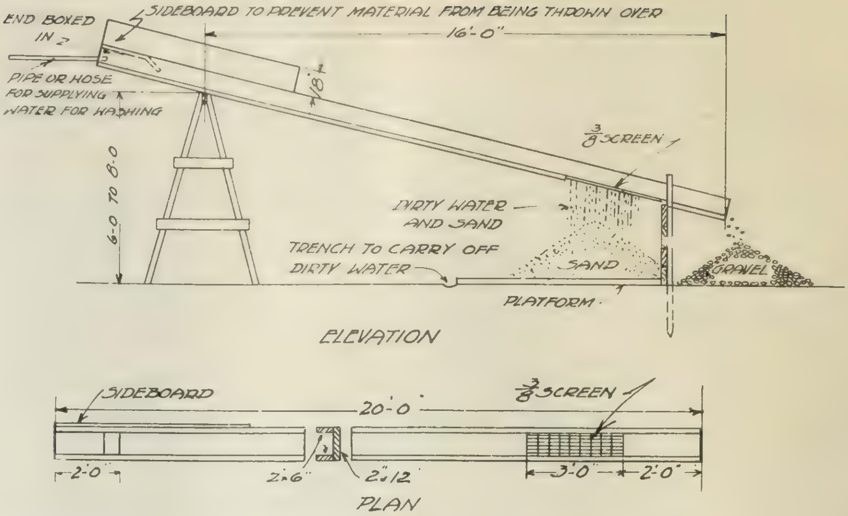
[1] Consult. Engr., Boston, Mass.

[2] Arch. and Engr., Newark, N. J.

[3] Co. Highway Commr., Milwaukee Co., Milwaukee

[4] Pres., Aberthaw Const. Co., Boston

[5] Engr. in Chg., Inf. and Insp. Burs., Universal Portland Cement Co., Chicago



Gravel Washing and Screening Apparatus

getting into the sand, due to improper stripping of the pit. He should note the general makeup of the pit, namely as to whether or not the sand occurs in layers of various sizes and also the possibility of some layers being hauled from the pit with sand of one size only.

If the foreign material in the sand is very fine clay, it might be removed by screening providing the sand is very day, but this is hardly probable under working conditions. The only other method that I know of, is to wash the sand.

By Mr. Wason

Our field test for sand is the common one of rubbing between the hands to see whether or not the material is dirty and to see whether or not it is gritty, and throwing it into a glass of water to test for the amount of fine material, which renders the water muddy, then mixing a small portion into mortar of about the consistency used in laboratory work, spreading it out thin on a sheet of glass as for the boiling tests of the laboratory and with makeshift needles filed out of wire nails, try the time of set of the cement. If the sand is of a poor quality it will retard setting. We also test the hardness of the cement at the end of one da. or two das.

If a thoroughly first-class sand of known quality is at hand, a comparative test will be made with it; then a boiling test will be arranged with the specimens in an iron pail to see whether or not the sand acts in a normal way under these conditions. If it does, we use it for our unimportant work where a failure would not be a serious matter, but for many years we have never used an unknown sand for important work like the construction of a building without first having laboratory tests made of it. In 1913 about a dozen samples failed to meet the standard requirements.

By Mr. Kinney

The field examination of concrete sands is a matter which would be rather difficult to treat in detail to the best advantage without consuming considerable space, and perhaps a reference to a bulletin that has been published by one of the engineering experiment stations will serve the purpose here. This bulletin is No. 34 of the Engineering Experiment Station, of the Ia. State Coll. of Agri. and Mechanic Arts and is entitled, "The Use of Iowa Gravel for Concrete." It contains a description of an outfit for gravel testing used by inspectors of the Highway Commissions of Ia. and Ill., costing about $3.50, also the methods of using this outfit in making a field examination of sand and gravel for concrete work.

Fine sand should always be avoided in concrete work, as it will not produce requisite strength without the use of an excessive amount of cement. It is often more economical to secure a suitable coarse sand from some distance, if necessary. Clay existing as a coating on the particles of sand aggregate is undoubtedly injurious, as proper adhesion between the cement and sand surface is then prevented. When, however, clay of a silicious nature in the form of separate particles exists to a small extent throughout the mass of aggregate, it appears to cause no serious harm in many kinds of concrete work. The presence of clay in sand may be detected by the well known method of rubbing the material between the hands or by stirring or shaking a small quantity of sand in a tumbler or bottle of water. A coating of vegetable matter on sand grains appears not only to prevent the cement from adhering but to affect it chemically. Consequently, the sand should be free from loam or vegetable growths. Sometimes the quantity of vegetable matter is so small that it cannot be detected by the eye and requires a careful analysis of the sand. Concrete made with such sand usually hardens so slowly that the results are questionable and its use is prohibited.

As far as economic methods for the elimination of foreign materials from the sand are concerned possibly the accompanying sketch of a washing and screening apparatus for bank-run gravel may be of interest to some.

The general arrangement of the apparatus is shown in detail and consists principally of a trough, set at such an incline that the aggregate will roll down by gravity, assisted by a water flow applied at the high end of the trough. The slope of the trough will depend upon the amount of water used and the nature of the aggregate to be washed. Consequently, the drawing shows this height at the upper end of the screeen as variable. Eight feet will not be an objectionable elevation, if the material to be washed can be dumped in a pile at the high end, so that the truck shovelers may work from the top of the pile, thus making it necessary to throw the material to the full 8-ft. height.

As operated on one job, water was in one case obtained from a flowing well, and at other times a gasoline engine, running a pump placed in a well, forced water to the pipe line, emptying it into the upper end of the trough. Gravel to be washed was dumped near the elevated end and shoveled from there into the trough, where gravity and the flow of water caused it to roll down, and as a result of this action loosened the dirt sufficiently, so that when the material reached the screen, dirty water and sand passed through, while the coarse aggregate passed on to the end of the trough. It was found necessary to scrape the coarser aggregate out of the lower end of the trough from time to time, as the pitch was not sufficient to cause the material to roll out after the water had passed through the screen. The material was washed as fast as it was used for concrete, eliminating the trouble of frequently removing it from the lower end of the trough. If it is desired to wash a considerable quantity, the trough can be arranged in such a manner that it may be moved in a line parallel to the material deposited at the end, thus eliminating shoveling it away. The cost of washing and screening material with this apparatus was estimated as ranging from 25 cts. to 30 cts. per cu. yd. But material was washed only as required for use, the output varying from 15 cu. yds. to 20 cu. yds. per da., with two men operating. More material per da. could probably be turned out if the mixing of concrete were not carried on at the same time and attention thus directed to increasing the capacity of the apparatus. Very satisfactory results, however, were obtained from this equipment and the contractor was so well pleased that he intends to again use the device under similar circumstances.

Good Practice in Concrete Block House Construction

Discussed By Wm. M. Kinney,[1] Rolf R. Newman,[2] Oswald C. Hering,[3] A. E. Cline,[4] J. K. Harridge,[5] C. R. Knapp[6]

"The writer's home is in Belgium. This inquiry is being sent from England, where I am living temporarily. I am making preparation for reconstruction work in Belgium, particularly in connection with moderate priced dwellings in which, I believe, concrete block can be used extensively, owing to the scarcity of clay brick. Any attempt which may be made, however, to introduce concrete block on a large scale should be well considered and mistakes which have heretofore been made in Belgium and which have, to some extent, discredited concrete block, should be avoided. I shall appreciate information along the lines suggested by the following questions:

"1. What is the best practice regarding insulation in concrete block and concrete tile walls, laid horizontally and vertically? In what system of block wall construction would it be safe to eliminate interior furring and lathing before putting on plaster?

"2. In the construction of a concrete cottage, the outside wall of which is built of single hollow block, could sufficient insulation be provided against moisture and temperature changes, with a 2-in. air space obtained by means of furring strips on the inside? It is proposed to build these cottage walls of a very thin block.

"3. In the construction of cottage walls of concrete block as mentioned in question No. 2, would it be advisable to put interior plaster direct on the block, providing the outside of the block were furred and lathed and covered with 1 1/2" of stucco, leaving an air space between the stucco and the block?

"4. As I understand it, the effectiveness of insulation depends upon the continuity of the air space. In concrete house construction where there is a double wall with continuous air space, would there be serious interference with insulation if floor beams projected through the air space and rested upon both outside and inside portions of the wall?

"5. If we use one-piece block with projecting lug on the inside and place furring strips vertically on these lugs, would it be good construction to plaster on lath fastened to these furring strips? Would the insulation be interfered with by the the condition be improved by placing furring strips? Would the furring strips be apt to rot out and would tar-felt between the concrete block and the furring strips?

"6. In a double wall construction with concrete block, do the galvanized ties ever become rusty so that their value is destroyed?

"7. Will marble chips, used as exterior facing material in concrete block, weather satisfactorily? Will not severe frosts cause disintegration of such a facing?

"8. With a large supply of crushed brick available, would it be good practice to use this crushed brick as an aggregate for the coarse backing of concrete block? Would a good bond be obtained between the facing and backing if the facing were used in this way?"

By Mr. Kinney

1. Interior furring and lathing may be omitted in construction which provides a continuous air space in the wall. If air space is not continuous, that is, if construction is simply of the hollow block or tile type, then furring and lathing will be necessary, especially where climatic conditions are such that temperature range is wide.

2. This question may be answered in the affirmative.

3. The practice outlined in question 2 would be preferable, although under most conditions no doubt the method outlined in question 3 would prove fairly satisfactory.

4. This question may be answered in the negative. Probably the only interference with insulation would be localized, and if evident would not extend beyond the limits of baseboards used in trim.

5. Presuming that the concrete block are impervious, we believe that the answer to this question can be "No."

7. If the marble chips used are from a dense marble, then the answer to this question is "No." Possibly a soft, porous marble would disintegrate. If, however, hard marble is used and the concrete mixture used in the block is properly proportioned to secure density and watertightness, there should be no disintegration of the facing.

8. Crushed brick, if clean, well burned, and therefore hard, and meeting the requirements of grading for other aggregate, may be used as aggregate in the manner suggested. A good bond will result between the facing and backing if the two are of proper and equal consistency when placed, and are placed without an interval of time elapsing.

By Mr. Newman

1. The best practice regarding insulation in any case is a liberal use of Portland cement and intelligent proportioning of the sand and rock used with it. Any system of well made block wall, at least 8" thick and comprising a 2-in. air space (not necessarily continuous) may be plastered upon directly, without the use of interior furring.

2. Using block thinner than 8", furring strips as mentioned would fully insulate against moisture and temperature changes; but in regard to the strength of the wall when coming below 8" in thickness, solid concrete will be found to have economic advantages over block or tile construction.

3. The construction inferred by this question could hardly be considered block construction as the exterior frame is of wood with $1\frac{1}{2}''$ of exterior stucco. So long as the exterior stucco remains intact the plaster blocks inside with air space as mentioned would undobutedly provide a satisfactory house, but the modern tendency is to use some form

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[1] Universal Portland Cement Co., Chicago

[2] Civil Engr., Riverside, Cal.

[3] Oswald C. Hering and Douglas Fitch, Archts., N. Y. C.

[4] Winchester, Mass.

[5] Barron & Harridge, Chicago

[6] Builder, Albany, N. Y.

of concrete or block construction that does not put so much responsibility upon the exterior plaster.

4. I do not understand that the effectiveness of an air space is contingent upon its continuity. I have placed floor beams upon interior webs where they were strong enough but I think to project them also through the outer shell of your block is an unnecessary complication of your insulation problem not justified by other considerations.

5. In using wooden furring strips I regard tar and felt simply as makeshifts which may or may not prolong the life of the resulting combination. A much surer method would be the use of metal furring strips mechanically fastened to the lugs of the block, as referred to in your question.

6. All metal in wall containing air spaces is subject to rust if moisture reaches it, and the only known preventive or modifier of this contingency is a liberal and proper use of Portland cement in the mortar in which the block are laid.

7. Marble chips or other exposed aggregates often weather remarkably well, but the use of these materials in the facing of block is so liable to lead to combinations of texture or color that are not in good taste that they are, as a rule, to be avoided. A plain faced block with good jointing makes a remarkably good wall—or rather is capable of making a good wall—so let us strive for better workmanship in plain walls and save the marble chips for special occasions.

8. The use of broken bricks in concrete work is permitted when they are fairly hard burned and when they have been well soaked before placing them in the concrete. Under these conditions I can see no objection to using them in the backing of a concrete block but I can see no real economy unless there be a great dearth of fine stone material and there would always be the danger of getting a piece too near the face that might provide a passage for moisture to the center of the block.

By Mr. Hering

My answers are based on the assumption that climatic conditions in Belgium are not so different from those around N. Y. C. that approximately the same specification cannot be used.

1. The only safe methods of insulation are those which provide a space for the free circulation of air between the outside and the inside wall surfaces, preferably between an outside bearing wall and an inside screen formed to hold the inside plaster or other finish. It would not be safe in dwelling houses to eliminate this air chamber—consequently furring may be omitted in the double wall construction only.

2. I do not know of any concrete hollow block less than 6″ thick. Always assuming that the block is capable of performing its function of sustaining the load and of keeping out wind and water a 2-in. interior furring, lathed and plastered, should be an effective insulation against moisture and temperature changes. If the block present no finished surface and are not of a dense mixture or laid with perfectly tight joints it would be well to paint them outside with a good waterproof paint.

3. I should not recommend this form of construction. It is putting the cart before the horse. The stucco would better be applied directly to the block on the outside and the inside of the block furred and plastered.

4. No, provided the beams mentioned are of wood or some other non-conductor of heat.

5. (A) Yes. (B) No. (C) Not if a dense block is used and the climate is normally dry. If any waterproofing is to be done it should be with the paints specified above, or equal to them, applied to the block on the outside. Waterproofing the inside of a wall is like locking the stable after the horse has been stolen. It is done only when the outside surface, for some reason, cannot be reached.

6. I do not know of any instance of the collapse of a double wall due to the disintegration of the iron ties. In America it is not generally considered a source of danger. But in America we do not build for posterity. If the ties rust then most of our "skeleton steel" buildings will in time have to come down—for unless steel is thoroughly embedded in concrete, as in reinforced concrete construction, it will eventually disintegrate.

7. (A) Yes, if strongly embedded. (B) No more so than marble block.

8. I am not sufficiently familiar with the action of brick as the chief aggregate to be able to give an opinion. In America it would not ordinarily be used as such, owing to its high cost.

By Mr. Cline

1. The use of some kind of furring strip or metal furring plug to hold the lath and plaster away from the walls, leaving a 2-in. space between the walls and plaster is recommended. In a climate not too cold one can plaster directly on the inside walls of any good waterproof block or tile, but where there is long-continued below-freezing weather, the walls become so cold that any moisture in the rooms will condense on the walls, even where no dampness can penetrate from the outside. A double wall with no webs reaching across should be a safe proposition.

2. Yes. especially so by using insulating paper (cold storage) between the strips and the block.

3. Yes, if the stucco were made impervious to moisture by some good waterproof mixture or paint.

4. Not serious, as wood is a poor conductor, provided the beams do not project through the outside wall. But it would not be good practice to do it. Leave them on inside wall only, then in case of fire the outside wall would not be disturbed by failure of the beams.

5. Yes. But use some form of waterproof insulating paper between the furring strips and the block; this will prevent any chance of decay of the strips.

6. Have never seen or heard of their doing so.

7. Yes, provided it is a good, hard marble. Have used both marble and limestone and have never seen it disintegrate, for the reason that the small pieces of marble do not have any seams or cracks through which water can enter, and the cement in which they are held forms a protective covering to all except the exposed surface.

8. Have never used crushed brick, but see no reason why good, hard burned brick should not make a fair substitute for gravel, when used with good sand. If facing and backing are made at the same time and either pressed or tamped together thoroughly, there is no danger of separation.

By Mr. Harridge

1. A very satisfactory method of securing insulation for the plastered surfaces of an interior wall, where a single unit in the shape of block or tile is used, is to use furring strips. This is found to be of good practice in all masonry walls. Security from the effects of frost and dampness, where it is desired to plaster directly on the wall, may be had by use of a two-piece construction.

2. With blocks reasonably impervious, the 2-in. air space secured by furring would be quite ample, in fact, in general practice a furring strip not more than 1″ thick is used. It should be sufficient so that the keys of plaster between the lath do not touch the block wall.

3. While plaster might safely be

applied directly to the block wall under the conditions mentioned in this question, if the stucco were made impervious, especially at the ground line, yet it would hardly be said to be advisable from a practical and economical standpoint. The method mentioned in query No. 2 seems preferable.

4. The continuity of air space horizontally is most valuable because it prevents any direct contact between the inside and the outside faces of the wall, insulating against frost where the block are made dense with wet mixture and against the transmission of dampness if block are not so impervious as they might be. Breaking up the vertical air spaces is a benefit if secured through the use of some material which will not conduct heat, cold nor dampness, such a good felt. The projecting of floor joists onto the outside walls need not interfere with the value of the air space; the wall on the inside would be carried up through slabs between the joists, sealing the air space.

5. The one-piece block with face and inwardly projecting webs, with furring strips fastened to web ends and then lathed, makes ideal low-price construction. The furring strip furnishes sufficient insulation for the plastered wall. The foundation for belief that the furring strips will last indefinitely results from their long use in other forms of masonry construction. Add a good building paper between the ends of the webs and the furring strips and you have two air spaces instead of one, securing an improved wall at very small expense. If this block is made of a wet mixture it should be sufficiently impervious to make tarring of the web unnecessary. There are a number of simple methods of attaching the furring strips to the webs of this wall, the simplest and one of the most satisfactory being to lay a loop of wire in the mortar joints as the wall is laid, later twisting the ends tightly around the furring strip.

6. In a double wall fastened together with wire ties, the ties probably will not rust out if of galvanized wire. Care must be taken in handling or the wires might become so loose as to make them useless. A two-piece wall of such shape as to make a bond between the inside and the outside faces of concrete without the need of wire ties is better construction.

7. Marble chips are quite satisfactory for facing concrete block, provided the block backing and the facing mixture of chips and cement are made wet, to insure a positive bond between the back and the face. The chips are protected by the cement coating which partially covers them, and with the imperviousness coming from the wet mixture (and careful grading) there is no deterioration from frost.

7. Brick if hard burned, free from dust and properly graded after crushing, would no doubt prove a satisfactory substitute for stone in the manufacture of block for the class of work in question. The brick aggregate would, of course, want to be thoroughly wet before mixing in order that the mixture might not be robbed of the moisture required for cement crystallization. The use of brick aggregates should make no difference in the matter of facing.

By Mr. Knapp

1. The interior furring and lathing may be eliminated from any hollow block wall and plaster put directly on the block, providing you have a good, dense block, well made, of good material and properly cured, and carefully laid up in cement mortar.

Editorial Discussion

In the foregoing discussions there is a difference of opinion in the matter of insulation in a concrete wall. Mr. Kinney says: "If the air space is not continuous, that is, if construction is simply of the hollow block or tile type, then furring and lathing will be necessary, especially where climatic conditions are such that temperature range is wide." Mr. Newman takes a directly contrary view. He says: "Any system of well made block wall, at least 8″ thick and comprising a 2-in. air space (not necessarily continuous) may be plastered upon directly without the use of interior furring." Mr. Hering says: "It would not be safe in dwelling houses to eliminate this air chamber—consequently furring may be omitted in the double wall construction only." Mr. Cline takes a middle ground: "In a climate not too cold, one can plaster directly on the inside walls of any good waterproof block or tile, but where there is long-continued, below-freezing weather, the walls become so cold that any moisture in the rooms will condense on the walls, even where no dampness can penetrate from the outside." Mr. Harridge considers continuous air space essential. Mr. Knapp says the furring can safely be eliminated and plaster applied direct on the wall, providing the block are dense and well made of good material, and properly cured and carefully laid up in cement mortar.

There have been differences of opinion on this subject, from the beginning of concrete block construction. Some of the early differences were undoubtedly due to a confusion of waterproofing and insulating, yet this can scarcely be the case in the discussions here presented.

So far as water or dampness coming through the wall from the outside is concerned, the only requisite is a good, dense block well laid up in good cement mortar. The belief is quite general that density and waterproofness do not insure such insulation as will prevent a cold wall, resulting in condensation when there is a relatively high temperature with considerable moisture present inside. We have heard repeatedly of one-piece block walls plastered direct on the inside giving perfect satisfaction, with no trouble from condensation of interior moisture. These have been regarded as exceptions, however, to the rule. The unit slab houses built at Forest Hills Gardens by the Sage Foundation Homes Co., under the direction of Grosvenor Atterbury[7] are not provided with continuous air space for insulation. The wall slabs are tubular but with webs, fairly comparable in extent to the webs in one-piece hollow block, extending from outside to inside. Asked about condensation, Mr. Atterbury said that occupants of the houses frequently had wet walls on "wash days" in cold weather, when there was an unusual amount of moisture inside. Is it not quite likely that the results depend a great deal not only upon the difference in temperature outside and inside, but also upon ventilation? Is it not more than likely that in a house only fairly well built in respect to wall insulation, condensation might not be serious, owing to a strong partiality of the occupants of the house for a great deal of fresh air, and that a "steaming kitchen" where ventilation is not good might very quickly show up the defects in the walls with respect to insulation?

It has been suggested that a "popcorn" concrete, very porous, but sealed outside with a good stucco covering to prevent absorption, might provide better insulation than a dense wall. The difficulty is in getting strength enough in such concrete without a thickness of wall which would be prohibitive.

We should like to hear from more builders who have had experience which they can relate in detail as to houses proving successful or unsuccessful when lacking a continuous air space, either in the wall itself or as provided by furring, for insulation.

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[7] Description in Concrete-Cement Age, Jan., 1915, p. 3

As to the possibility of making use of crushed brick in concrete, *The Iowa Engineer* publishes the result of tests to determine the suitability of burnt clay wastes as coarse aggregate for concrete.

In Apr., 1914, a few interesting tests of the value of the refuse burnt material from an Iowa clay products plant were made by the Structural Section of the Engrg. Experiment Sta. The report continues:

Two reinforced concrete beams were made, in which the burnt clay was used as coarse aggregate for one and crushed limestone for the other. The cement and sand were the same in both beams. Six-in. cube specimens for crushing tests were poured with the beams.

Proportions of concrete materials, 1:2:4 by volume.

The beams were 10′ long, 20″ high and 10″ wide, reinforced 1″ above the bottom with four ⅜-in. x ⅜-in. corrugated bars. Two of the bars were bent up 18″ from each end. Two vertical stirrups were also used near each end. The beams were reinforced to develop the strength of the concrete itself.

The beams were tested when 28 das. old, on supports 9′ apart, under center loading, failing under loads as given below. Both beams failed by crushing near the point of application of the load and by diagonal tension in the center half of the length.

Burnt clay aggregate.....65,000 lbs. total load
Crushed stone aggregate.47,500 lbs. total load

Average strength, 6-in. cubes	28 das.	38 wks.
Burst clay aggregate........	1,250	3,680
Crushed stone aggregate.....	860	2,300

The physical characteristics of the two coarse aggregates were as follows:

Weight per cu. ft...........	Clay....	71.0 lbs.
	Stone...	93.0 lbs.
Absorption, lbs. per cu. ft...	Clay....	5.50 lbs.
	Stone...	2.83 lbs.

GRANULOMETRIC ANALYSIS.

Passing Sieve No.	1	2	4	8	30	50	100
Clay	63.1 %	10.57%	.33%	.10%			
Stone	83.86	33.82	9.72	3.6	1.39	1.01	.66

Although the scope of the tests was not sufficient to justify the formation of any conclusion, still the work is of much interest, as indicating a good use for a large amount of waste material.

It is the intention of the Engrg. Experiment Sta. to start a thorough investigation of this and some allied problems as soon as possible.

In regard to relative cost of a reinforced concrete fireproof mill and one with brick walls and wooden floors, the former used to cost about 15% more, on the average. As improved methods have been developed in the handling of men and materials on reinforced concrete, the prices have more nearly approached one another. In a number of cases they meet, and in a few cases the reinforced concrete building is cheaper in first cost.—L. C. Wason.

Correspondence: A Department in Which the *Reader* Becomes the *Writer*

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

ONLY HOUSE AT AVEZZANO, ITALY, UNDAMAGED BY EARTHQUAKE, BUILT OF CONCRETE BLOCK

Only House to Withstand Earthquake

A LETTER FROM ORESTE COARI[1]

The accompanying illustration shows a house built of concrete block at Avezzano, Ital. It is the only house to remain standing, undamaged by the earthquake of Jan. 13, 1915.

This earthquake was a veritable explosion. All houses of the country and of the principal town, Avezzano, collapsed. The verified mortality is 29,973 and 372 municipalities were ruined. In Avezzano, a town of 20,000 inhabitants, the houses were, for the most part, erected with bad mortar and irregular calcareous stones and a few bricks.

Oil for forms can be made by melting together kerosene and paraffin in the proportions of 1½ lbs. paraffin to 10 qts. kerosene. This oil is transparent and does not discolor concrete. When the concrete is to be plastered use no oil and if it is practicable use rough surfaced lumber.

Coloring Concrete Surfaces While Finishing

A LETTER FROM W. W. BERRY[1]

As the Arizona sun is very bright it was desired that the surface of the concrete walks recently laid here be as dark as possible. The surface was a 1:2 mixture, ¾″ thick. To get the necessary dark color it took 2 lbs. of lamp black for every 25 sq. ft.

By mixing the lamp black in a very little water and then slowly adding water much in the manner that a cook mixes cornstarch flour, the resulting mixture is free from lumps and about the consistency of thin paint. Just before the finish troweling the black mixture is liberally spattered over the cement top, which is immediately troweled. The lamp black makes the trowel slip well and the resulting color depends upon the amount of the black spattered over the surface. By this method a very black surface can be obtained by the use of 1 lb. of lamp black for every 400 sq. ft. to 500 sq. ft. of surface.

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[1] Rome, Italy

[2] Fort Huachuca, Ariz.

Field Methods In Concrete Construction

(Continued from p. 288)

nailing strips or cleats on the sides, especially where the studding is used on different floors, and the stories vary in height. Such practice is not to be recommended, because it is difficult to get a good square bearing where the two pieces of the studding abut, and often the shores are dangerous from the fact that the ends of the shores and the piece used to make the extension do not bear squarely and are held from failure by the cleats nailed on the sides. Careful attention must be given to piecing out the shores when used in the construction of the upper floors of an exposed building, as a combination of circumstances, such as a heavy wind storm, with the wet concrete just placed, might cause a failure of the supports.

If the shores must be spliced, there should be cleats of 1-in. stuff nailed on all four sides, though it is usual to find that one of the cleats has been left off. Ledger boards or braces should be used to brace these splices against possible failure, especially where numerous shores have to be spliced.

WEDGES

Wedges should be used to obtain the correct adjustment of shores, being driven in pairs to an even bearing. They should be loosened and removed without producing undue strains in the floor system. In order to be easily accessible when adjustments are necessary, wedges should preferably be on the floor at the bottom of the shores. The wedges should be nailed after leveling up forms so that there will be no slipping, or the wedges may be made sharp and thin enough to stick without being tacked. The outside surfaces of any two wedges should be parallel and cut from 2-in. x 4-in. scantling.

FOOTINGS FOR SHORES

Form work for a reinforced concrete floor is so carelessly constructed at times that the ends of the shores rest upon comparatively green concrete or soft ground or on a tile floor in such a manner as to allow the beams and girders to sag under the weight of the wet concrete. If the shores are not properly supported, they are sure to be pushed into the green concrete, into the ground, or to break the tile, causing a sag and possible cracks in beams and floor slabs. The concrete sets with this sag in the beam and slab members, and the entire floor system looks as if it were greatly deflected.

No shoring should be erected over soft ground or concrete less than a week old (never over tile floors) without a footing block of at least 3-in. x 10-in. plank, 3′ long for ordinary soil, while for soft soil, several planks should be crossed, in order to get sufficient support to prevent settling under the weight of the concrete.

CAPS FOR SHORES

The shores should be properly capped with plank or scantling to distribute the pressure, especially where the shores are used to support floor slabs or beams after the forms have been removed.

COVERING SLAB FORMS WITH PAPER

The use of resin-sized sheathing paper lapped 1″ at joists and tacked in place for forms under floor slabs needs constant attention in order to secure satisfactory results. It it somewhat difficult to keep the paper absolutely smooth, so that the final surface does not show wrinkles. The paper is easily torn in placing reinforcement and in shifting the forms, requiring much patching. Unless the paper is very oily it will adhere to the concrete, necessitating that it be burned off so as to effect its removal, as a thorough soaking very seldom removes the paper entirely.

Eighteenth Annual Meeting of American Society for Testing Materials

The 18th annual meeting of the Am. Soc. for Test. Mat. will be held at Hotel Traymore, Atlantic City, N. J., June 22-26, 1915.

Thursday, June 24, is given up to papers on testing apparatus and to reports and papers on cement and concrete as follows:

ON CEMENT AND CONCRETE

Report of Committee C-1: On Standard Specifications for Cement. G. F. Swain, Chairman.

Report of Committee C-9: On Standard Tests of Concrete and Concrete Aggregates. S. E. Thompson, Chairman.

Microstructure of Concretes. N. C. Johnson.

The Effect of Finer Grinding and a Higher SO_3 Content upon the Physical Properties of Portland Cement. P. H. Bates.

An Investigation of the Strength and Elastic Properties of Concrete-Filled Pipe Columns. A. F. Holmes and F. W. Swain.

Some Abrasive Tests on Portland Cement Mortars to Select Aggregates and Mixes for Concrete Highways. H. S. Mattimore.

Method of Weight-Volumetric Proportioning of Concrete Aggregates in Testing. J. A. Kitts.

Organizations

American Concrete Institute, Charles L. Fish, Secretary, Harrison Building, Philadelphia, Pa.

American Concrete Pipe Association, Secretary, E. S. Hanson, 538 S. Clark St., Chicago.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Colorado Bldg., Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Bellevue Court Building, Philadelphia, Pa.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; Robt. F. Hall, Secy., Chicago Cement Show, Coliseum and Light Infantry Armory, Feb. 12-19, 1916.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

Mid West Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

New Officers of Cement Products Exhibition Co.

A changed personnel constitutes the new administration of the Cement Products Exhibition Co. At the annual meeting of the stockholders, May 11, directors were elected as follows: B. F. Affleck, J. P. Beck, W. E. Cobean, Wm. Dickinson, A. Y. Gowen, Edward M. Hagar, Robt. F. Hall, D. McCool and J. U. C. McDaniel.

The new officers are: B. F. Affleck, president, succeeding Edward M. Hagar; A. Y. Gowen, vice-president; Robert F. Hall, secretary, and J. U. C. McDaniel, treasurer.

The Portland Concrete Co., Portland, N. Y., for a number of years has been manufacturing cement porch boxes in quite a large way. It is interesting to know that the business has grown to such proportions that a new company is to be formed, known as the Lake Erie Porch Box Co., with a capital of $50,000, to carry on the enlarged business. This is another illustration of one of the many uses of cement and how the industry grows apace in every direction.

Paints to Prevent Electrolysis in Concrete Structure[1]

The use of a paint as a protective covering for reinforcing steel against damage by electrolysis has often been proposed but the writer is aware of no tests having been made to determine a type of coating best adapted for this purpose.

Paints having a high insulating value are generally those drying with a high gloss, which is apt to prevent proper bonding, a fact which has undoubtedly prevented a general use of this protection. A method for overcoming this objectionable feature was developed by these experiments.

Corrosion Causes—It may be well to review briefly the causes of corrosion in reinforcing steel for the benefit of those not thoroughly familiar with the subject.

The ordinary forms of iron corrosion have been found to be due to auto-electrolysis, the presence of segregated impurities being responsible for differences in potential at certain areas, which set up galvanic action and cause solution and the formation of rust at the positive nodes. A similar but more rapid action takes place when an electric current is passed through an iron anode immersed in an electrolyte, such, for instance, as salt water. When damp cement contains an embedded iron anode the cement acts as an electrolyte, and the same rusting action takes place, regardless of the fact that concrete contains sufficient lime to inhibit corrosion when no electrical currents are present. With the electrolytic change of metal into oxide comes an increase in volume of the products of reaction, and there is developed an enormous expansive force of mechanical pressure, which is sufficient to crack the strongest forms of concrete.

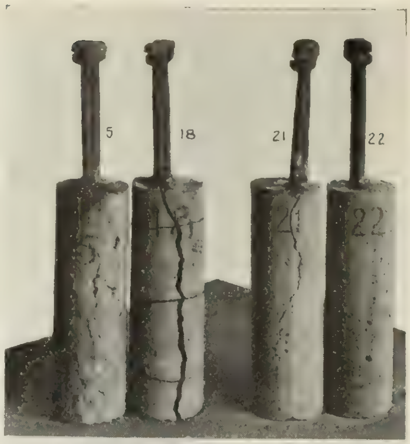
Engineers are active in their endeavors to prevent high voltage currents from running wild, but this fact does not justify a disregard of precautions against stray currents.

Preparation of Specimen and Methods of Testing—The tests were made on two series of specimens as follows:

1. Rods $\frac{1}{2}''$ x $12''$, painted two coats and embedded in concrete cylinders.

2. Rods $\frac{3}{4}''$ x $12''$, embedded as anodes in cylinders of concrete.

All cylinders were $3\frac{1}{2}''$ x $8''$ of cement mortar 1:2. The molds were removed in 2 das. and the cylinders aged for 1 mo.



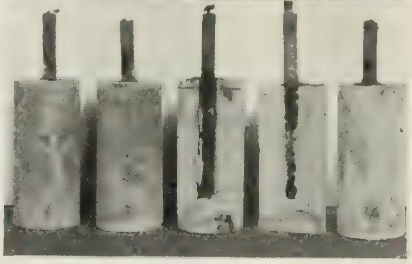


Fig. 1—Typical Specimens of Series I
Fig. 2—Typical Specimens of Series II

Tests on Series 1 were made by immersing the lower $2''$ of the specimens in water, connecting them in parallel and passing through them a direct current at 30 v.

Observations were made for 1 wk., when small cracks began to show near the bottom on a few specimens.

The specimens were then immersed to within $1''$ of the cylinder tops, the current turned on, and observed for 10 das. Cracking was shown by every cylinder carrying an appreciable amount of current, the fracture starting at the anode.

Wherever the protecting film broke down the increased passage of current resulted in rapid corrosion of the steel, followed by the expansion and bursting of the concrete cylinder.

Series 2 were tested by placing them in individual earthen jars containing sheet iron cathodes coiled around but not touching the cylinders. The jars were filled with water to within $1''$ of the top of the concrete.

The cylinders were connected in Series 1 and current passed at 30 v. for 240 hrs., when seven specimens developed cracks. The voltage was increased to 55 v. and continued for 60 hrs.

Observations on Tests—In the specimens in which cracking occurred the anodes showed considerable rust, the paint coatings having been broken down. On the cathodes in Series 1 the paint coatings were still intact, although some had apparently been affected by moisture and the hydrated lime in the wet concrete, chalky surfaces being shown.

The coatings on anode and cathode bars which were embedded in cylinders which did not crack and which carried little current were in a good state of preservation.

Bonding Tests—In order to determine the comparative bonding strength of rods coated with the various paints a duplicate of Series 2 was made with the exception that the rods were placed flush with the bottom of each cylinder. At 3 wks. the specimens were placed on an iron block drilled with a 1-in. hole and tested in a Riehle[2] testing machine. Some paints that proved to be good insulators failed to show bonding strength and vice versa. When painting rods in order to overcome the objection to using paints which dry to a gloss surface and prevent proper bonding, these coatings were dusted while tacky (not wet) with sharp particles of sand, which formed a rough surface, assuring a good bond. The corrosion of metal embedded in concrete structures, by stray currents of high voltage, is often productive of serious effects. The use of properly made paints upon such metal constitutes a safeguard that should not be neglected by the engineer. Such paints may be prepared from the following substances:

The vehicle should contain:

Boiled or bodied oils or products which dry to a fairly saturated film.

Oils which dry by semi-polymerization rather than oxidation.

Oils which dry to a flat rather than a highly glossed surface.

The solid portion should contain a percentage of:

Pigments which are coarse and which, therefore, tend to form films having a rough surface.

Pigments which are inert and which do not act as conductors of electricity.

Pigments which are either basic or of the chromate type.

The painted metal should be "sanded" if possible.

Even high school students are not exempt from lectures on Portland cement. Out at Phoenix, Arizona, the other day the pupils of the Glendale High School learned all about the manufacture of this important engineering commodity when Lindley C. Morton, representative of the Southwestern Portland Cement Co., addressed them on the subject.

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[1] Abstract of a paper by Henry A. Gardner, Asst. Dir., Inst. of Industrial Research, Washington, D. C.

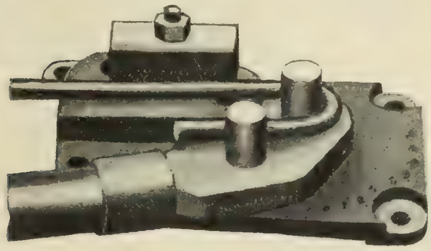
[2] Riehlé Cement Testing Machine Co., Philadelphia

New Equipment, Methods and Materials:

New Tools with Which the Industry Works □ □

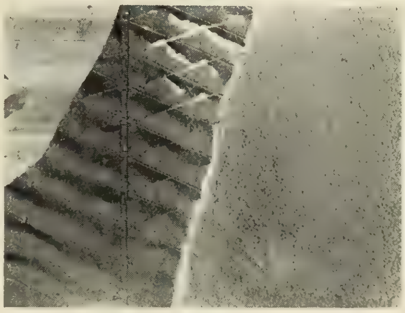
This magazine will not publish "reading notices," so-called, for the benefit of advertisers. These pages are edited for the Reader, as are all other pages in "Concrete." Manufacturers are constantly producing new and better methods and developing old methods, materials and machines. The progress of the concrete field is measured by the development of its tools. All developments along these lines are of real interest and importance to men who want to improve the quality of their work, decrease its cost, increase its quantity. This department is for just that kind of Editorial material. We, therefore, welcome detailed announcements which will be of practical value to Readers. Under no circumstances will this magazine publish any announcement simply because an advertiser asks it, nor refuse publication because a non-advertiser asks it. Material must carry information of real consequence to the reader. All material will be edited on that basis regardless of the source from which it comes.—The Editors.

Hinman Bar Benders


Hinman Bar Bender

One who has had occasion to bend a few bars for reinforcing purposes by methods extemporized in the field and who is confronted with a job requiring the bending of a considerable number of rods will appreciate the compact piece of equipment illustrated. This tool is one of the Hinman[1] family known as No. 3, it will bend bars up to 1¼" cold. Other numbers of the same family will meet demands for other work.

A New Stucco Base


E-Cod Fabric for Stucco

Many stucco troubles are caused by the lack of a proper "clinch," allowing the metal to rust. This is particularly true where the metal is in contact with wood.

As shown by the cut this new fabric, E-Cod,[2] is an innovation as it consists of a large, loose wire mesh, interwoven with waterproof felt. When applying the mortar the felt is pushed away, leaving the wire well embedded. The comparatively large section of the steel is an important factor in the permanence of the stucco, while the waterproof felt gives a valuable additional damp-proofing and insulation aside from its function as a plaster base. It is claimed that the use of this material is very economical as it prevents waste of mortar and is applied very rapidly.

A New Preparation for Securing Dustless Concrete Floors

It is recognized as a fact that concrete floors can be so carefully laid as to avoid the dusting that is so often a disagreeable feature. Freedom from dusting is to be secured by very careful selection of aggregates and by special care in mixing, placing and curing the concrete. It is often the case, however, that some of these conditions can not be controlled and special surface treatment of the floor is necessary to secure a satisfactory wearing surface.

Many preparations have been developed for treating floor surfaces, one of which is known to the trade as Dustite.[1]

This material is not a paint but comes to the user in the form of two powders, A and B, which are both mixed with warm water and applied to the floor alternately. A chemical reaction takes place, resulting in a surface said not to be soluble in water, oils or acids, and if necessary the floor can be in use while being treated.

The makers point out that a concrete floor with large, rough voids is better for treatment with Dustite than an extremely fine surface, as this coating fills voids in the concrete with a plastic material.

Dustite is easily and quickly applied with mop or brush in alternate coats of A and B until the floor is filled.

After the reaction has taken place the excess Dustite can be removed with a mop and warm water. This material does not come in colors but leaves the floor in its natural appearance. The treatment is said to be exceptionally low in cost and so simple as to be handled by inexpensive labor.

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[1] D. A. Hinman & Co., Sandwich, Ill.

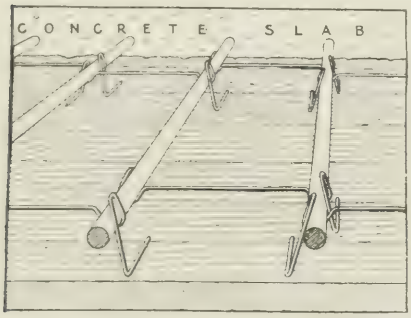
[2] E. D. Coddington Mfg. Co., North Milwaukee, Wis.

[1] The Dustite Co., Chicago

The Addy Bar Spacer and Supporter

The Addy bar spacer and supporter[1] is a light wire device for accurately spacing and supporting bars in floor slabs.

The illustration indicates that this spacer can be quickly placed and that it will prove economical in use. It would seem to be valuable as a light transverse reinforcement.



Method of Using the Addy Spacer

The Efficiency Bar Bender

A low-priced bar bender with a capacity up to 1¼-in. cold bars and yet so compact and light as to be carried in the small job locker is an attractive proposition.

The illustration shows such a piece of equipment known as the Efficiency bar bender.[2] This machine will bend plain, round, square, deformed or square twisted bars to any angle. It will also bend hooks on the ends of bars for anchorage.

Efficiency Bar Bender

It is constructed entirely of steel, and weighs about 70 lbs. The lever used is a piece of ordinary 2-in. pipe which is easily removed. This form of lever permits the easy use of different lengths suited to the work in hand.

A New Portable Stone Crusher

A portable crushing rig that will make a strong appeal to the contractor who is not fortunately situated with respect to gravel and crushed stone supply is shown in the accompanying illustration.

Such equipment will often effect economy over hauling materials and not infrequently dispose of stone that it is desirable to get out of the way. This machine is known as the No. 7 Contractor's Portable Crushing Rig[1] and consists of a No. 7 Telsmith Jaw Crusher with an opening 7" x 10" having a capacity of 2½ tons per hr. of ½-in. size, of 3 tons to 4 tons per hr. of 1½-in. size.

The elevator is of the single chain type and has a folding section at the top, to reduce the headroom required.

The standard rig is equipped with a chute screen. Perforations are made to suit. If preferred, the rig is furnished with a rotary screen.

This equipment is finished with a flat bottom portable bin with four bin gates, available capacity of five tons. Gravity capacity is about 3 tons.

The crusher is driven by a 12-h.p. double-opposed-cylinder engine.

The whole rig is mounted on an all-steel truck, with 8-in. channel sills, strongly braced.

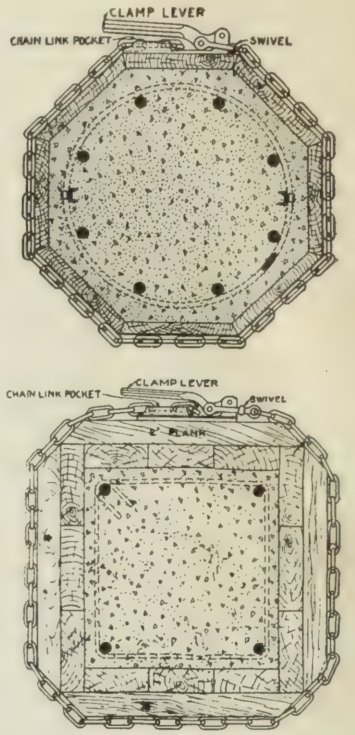
This equipment weighs about 9,000 lbs. A rotary screen will add about 400 lbs. more. Two horses will move it on a paved street, and four horses will probably take it anywhere it is likely to be used.

Link-Belt Electric Hoist, Bulletin No. 207. Link-Belt Co., Chicago, paper, 6" x 9", 4 pp., illust. This folder discusses the advantages of the Link-Belt electric hoist, emphasizing such features as small sibility to all parts, etc.

Telsmith Portable Crushing Rig

A Chain Clamp for Column Forms

The accompanying illustrations show the D-C chain column clamp,[1] which can be applied directly to round or octagonal column forms. When applied to square columns



The D-C Chain Column Clamp

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[1] Lewis N. Lukens, Philadelphia

[2] Electric Welding Co., Pittsburgh

[1] T. L. Smith Co., Milwaukee

[1] Olney J. Dean & Co., Chicago

short pieces of 2-in. plank can be placed around the form as shown and re-used on the next column. Clamps are usually supplied in 8-ft. and 10-ft. lengths and will fit with equal readiness any shape and size of column.

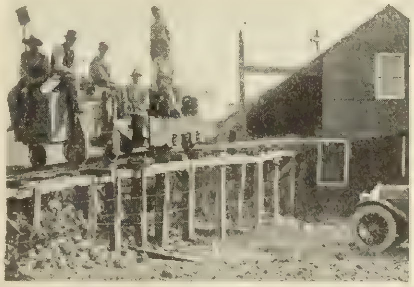
The swivel link between the lever and the chain prevents twisting of the latter. The clamp is placed without wedges, the use of which makes it difficult to tighten the clamp without forcing it out of place. A "take up" of over 3″ is obtained in the chain, and the leverage obtained is amply strong to hold the largest column form securely. Any amount of leverage can be obtained by placing lengths of pipe over the clamp lever. To remove the clamp, force out the lever, thus causing the clamp to fall to the ground.

The Plymouth Gasoline Locomotive

In handling concrete material as well as in the problems of handling excavated material and grading, a narrow-gauge railway is often the most economical equipment. A locomotive that is adapted to this work, with gasoline as its motive power, giving to it instant readiness for action and low operating cost, is a unique and practical answer to this problem. The illustration shows the Plymouth locomotive[1] hauling 10 cars containing from 1½ yds. to 2 yds. each of clay and stone, and above, hauling a clay car with 1¼ yds. of clay up a 10% grade, 150′ long.

This is a 2½-ton to 3-ton locomotive, made in 24-in., 30-in. and 36-in. and standard gauges. It will handle a load of 30 tons on the level and is also powerful on heavy grades.

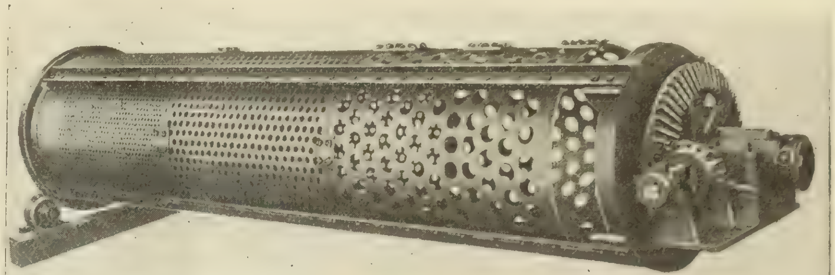
The engine is a Continental, Model N, 3½-in. bore, 5-in. stroke, 4-cylinder water-cooled gasoline engine, rated at 34 h.p. at 2,000 r.p.m. The machine is simple and can be operated by inexpensive labor. A unique attachment is a device for automatic control of the gasoline feed; it adjusts the mixture to the work the engine is doing, effecting a saving in gasoline. Contractors, as well as manufacturers having plants requiring the hauling of bulk materials, are finding this equipment satisfactory and economical.



Revolving Screens for Sand, Gravel and Crushed Stone

The accompanying illustrations show two new types of Hesse-Martin revolving screens,[1] which are so constructed that the inside is entirely unobstructed by shaft or spiders. The screens are set up at an angle of approximately 15° and revolve at a speed of from 10 r. p. m. to 20 r. p. m., according to size.

The drive is effected at the lower end, by means of a set of bevel gears, and the rotary motion is transmitted by means of four steel channels. The upper end has securely fastened to these channels the head, which consists of a heavy ring provided with a hardened bearing rim which runs on two chilled rollers.



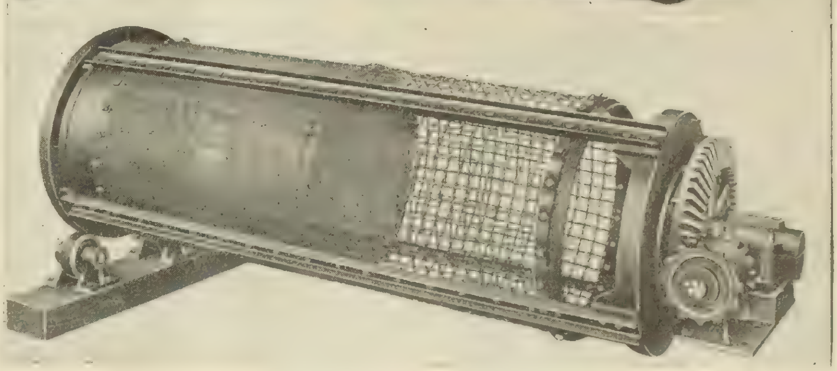


Fig. 1—Revolving Screen Used for Crushed Rock

Fig. 2—Revolving Screen Used for Sand and Gravel

The entire structure presents a rigid cylindrical beam supported at both ends. The bearings, while of simple construction, are generous in proportion, having sufficient means of lubrication and are well protected from dust. The main and the countershaft bearings are mounted on the same sole plate, permitting easy adjustment of the bevel gears and yet forming a rigid angle box.

Any section of the screen may be readily taken out and replaced.

The screen shown in Fig. 1, having a lining of perforated plate steel, is used mostly for crushed rock, while gravel is preferably treated by means of the screen shown in Fig. 2, which has a covering of heavy wire mesh.

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[1] J. D. Fate Co., Plymouth, Ohio

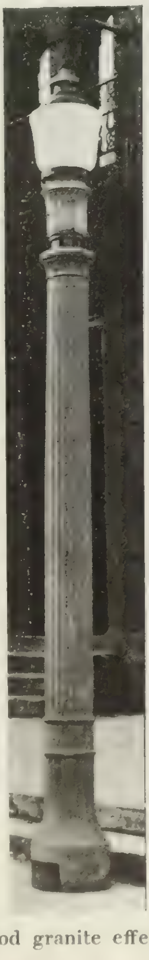
[1] Hesse-Martin Iron Wks., 400 Belmont St., Portland, Ore.

The capacity of either screen may be materially increased by means of a dust jacket around the first section, which is not shown in the illustration.

New Light Standard

There is nothing particularly new in the mold for the light standard shown in the accompanying illustration, except the architectural quality. There has been a gradual change, in most cases for the better, in so-called architectural molds—standard metal molds for making ornamental specialties. This illustration comes from George W. Edgcumbe[1] who markets the molds and manufactures the standards as well. Details of some of his practice in making lighting standards will be of value to other producers.

He says:



I usually make the standard illustrated with mica spar[2] and white cement, using various sizes of the facing to make a solid mass, and wetting it to a damp mixture. This is thoroughly tamped into the shaft mold, taking great care in tamping so as to give a uniform solid surface the full length of the post. This is accomplished by putting in a small amount of concrete and thoroughly tamping, otherwise there is great danger of having it show in layers. We use either a 4-in. galvanized pipe or boiler tubing for the core, providing the space for the conduit for the wiring. The service box in the base of the pedestal is cast in the mold, giving ample room for necessary electrical connections.

It is necessary to leave the product in the mold for 24 hrs. Then we remove it, and let the post stand for a day, after which time we wash it with a weak solution of muriatic acid and water, which gives a good granite effect which weathers well.

When the base is set in the footings, we use 1-in. or 1½-in. conduit which bolts into the service box, then pour in the slush concrete from the top of the shaft, which makes a solid mass from top to bottom. In making the pedestal, we usually cast in three ½-in. or ¾-in. rods, letting them project about 12″. In casting the footings or base for the post, we cast in three 2-in. pipes which we fill with slush concrete when setting the projecting rods of the pedestal into the pipes in the base. This anchors the pedestal to the base very solidly.

These standards require no up-keep, are anchored to the sidewalk or footings better than it is ordinarily possible to anchor an iron post, and from an economical standpoint they are about 50% cheaper than iron posts based on the same size and design. From an artistic standpoint there is no comparison.

Current Prices — Concrete Materials □

Portland Cement—The present condition of the cement market is the dullest experienced in the past four years. The indication is, however, that the market will pick up shortly, this being based on the increased number of jobs out for estimating. In the Pacific Coast territory the market is dull in all lines but with a little better inquiry than six months ago. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, $1.46; New York, $1.22; Chicago, $1.46 to $1.55; Pittsburgh, $1.46; New Orleans, $1.58 on dock; Memphis, $1.75; Cleveland, $1.54; Detroit, $1.55 to $1.65; Indianapolis, $1.58; Columbus, $1.58; Cincinnati, $1.59; Toledo, $1.59; St. Louis, $1.46; Milwaukee, $1.58 to $1.63; Minneapolis and St. Paul, $1.67 to $1.73; Duluth, $1.82; Kansas City, $1.48; Omaha, $1.48; Spokane, $1.75; Seattle, $2.20; Portland, Ore., $2.20; Tacoma, $2.20.

Crushed Stone—1½-in. stone, prices per cu. yd., f.o.b. cars in carload lots, unless otherwise specified. Boston, 80 cts. per ton at the quarry; New York, 95 cts. in full cargo lots at the docks; Chicago, $1.15; Spokane, $1.15; Portland, Ore., $1.30; Seattle, $1.65.

Gravel—Prices given are per cu. yd. f.o.b. cars in carload lots unless otherwise noted. New York, 80 cts. in full cargo lots at docks; Chicago, $1.15; Spokane, $1.00; Portland, Ore., 85 cts.; Seattle, 75 cts.; Tacoma, 75 cts.

Sand—Prices are per cu. yd. f.o.b cars in carload lots unless otherwise indicated. New York, 50 cts., full cargo lots at docks; Chicago, $1.15; Spokane, 75 cts.; Seattle, 75 cts.; Portland, Ore., 85 cts.; Tacoma, 75 cts.

Reinforcing Bars—The bar market is normally active in New York, Chicago and St. Louis, while the mills in San Francisco are operating on a limited scale, business being spasmodic. June deliveries will be made on a basis of $1.20 per cwt., Pittsburgh, with prevailing extras for bars under ¾″ or base. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, $1.369; Philadelphia, $1.359; Chicago, $1.389; Spokane, $2.05; Portland, Ore., $1.80; Seattle, $1.85; Tacoma, $1.85; San Francisco, $1.70.

Shipments from stock are being made at the following prices per cwt. f.o.b. cars: Pittsburgh, $1.65; New York, $1.85; Philadelphia, $1.70; Cleveland, $1.80; St. Louis, $1.80; Chicago, $1.85; Spokane, $2.25; Portland, Ore., $2.15; Tacoma, $2.15; Seattle, $2.15; San Francisco, $1.70.

Metal Clips for Supporting Bars—$4.50 to $6.50 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed. (Note increase in Freight Rates.)

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16.9	cts.
New York	16.9	“
Philadelphia	15.9	“
Baltimore	15.4	“
Boston	18.9	“
Buffalo	11.6	“
Cleveland	10.5	“
Birmingham	45	“
Cincinnati	15.8	“
Chicago	18.9	“
Denver	68.6	“
St. Louis	23.6	“
New Orleans	30	“
Minneapolis	32.9	“
Indianapolis	17.9	“
Kansas City	43.6	“
Omaha	43.6	“
Pacific Coast Points (Rail)	80	“

Now that the Panama Canal has been opened to traffic ocean freight rates on reinforcing bars to Pacific Coast points have been established which materially lower the delivered cost of bars from the east. The rates per 100 lbs. to Pacific Coast points for large lots are: From Pittsburgh, 61.9 cts.; Chicago, 76.5 cts.; Youngstown, 63.9 cts.; New York, 45 cts.; Bethlehem, 52.9 cts.

Trade Publications □

The Engineering Department, State Coll., of New Mexico, has published a special number of *The Round Up*, a weekly college publication containing interesting notes of engineering activities in the Southwest.

Medusa White Portland Cement—Sandusky Portland Cement Co., Sandusky, Ohio, paper, 9″ x 7″, 32 pp., illust. This booklet describes in minute detail the use of Medusa White Portland cement for building ornamentation, concrete building block, interior decoration, cemetery work, parks and grounds, tile, mosaic, statuary, etc. The method of using this cement for stucco work is also thoroughly described, and illustrations given of typical buildings wherein this cement has been used. Testimonial letters are also given from many users of Medusa cement.

Medusa Waterproofing Paste—Sandusky Portland Cement Co., Sandusky, Ohio, paper, 5½″ x 3¼″. A 4-pp. folder describing the use of Medusa Waterproofing Paste, with the quantities required, and pointing out the convenience of the paste over the powder form formerly manufactured by this company.

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[1] Benton Harbor, Mich.

[2] Crown Point Spar Co., N. Y. C.

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Concrete

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ENGINEERING

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